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ARTICLES

WEEDS OF VEGETABLE CROPS AND THEIR CONTROL

H. A. Roberts

National Vegetable Research Station, Wellesbourne, Warwick

Investigations on the weeds of vegetable crops and their control have been started recently at the National Vegetable Research Station, and it was felt that a general picture of the problems and of the control measures in current use would be of value in orientating the proposed research. To this end, the assistance of the Horticulture Officers of the N.A.A.S. was sought in answering a series of questions on these subjects. The information received in thirty-nine replies from all parts of England and Wales has proved very useful and, as it may be of some general interest, the more important points are discussed in the present article.

Annual Weeds

One of the main objects of the inquiry was to obtain information regarding the relative frequency with which the different annual weeds occur in vegetable crops. Although some thirty species were reported as being of common occurrence, many of these were only mentioned in the lists from one or two areas. Table 1 shows those weeds which appeared in four or more of the lists received, species mentioned an equal number of times being bracketed. It is well known that the weed flora of land on which vegetables are regularly grown tends to differ in composition from that associated with agricultural cropping, and this is brought out in the table. Such common agricultural weeds as charlock and wild radish are low down in the table, and others, such as poppies (*Papaver* spp.) and cleavers (*Galium aparine*), are absent.

Table 1

The Most Common Annual Weeds of Vegetable Crops

(Arranged in the order of frequency indicated by the inquiry)

Common Name	Scientific Name
Chickweed	*Stellaria media*
Annual nettle	*Urtica urens*
Fat-hen	*Chenopodium album*
Annual meadow grass	*Poa annua*
Groundsel	*Senecio vulgaris*
Redshank	*Polygonum persicaria*
Shepherd's purse	*Capsella bursapastoris*
Speedwells	*Veronica* spp.
Mayweeds	*Matricaria* and *Anthemis* spp.
Wild radish	*Raphanus raphanistrum*
Black nightshade	*Solanum nigrum*
Charlock	*Sinapis arvensis*
Fumitory	*Fumaria* spp.
Knotgrass	*Polygonum aviculare*
Sowthistles	*Sonchus* spp.
Corn spurrey	*Spergula arvensis*

Information was also sought as to the most important weeds ; that is, those considered by growers to be the most troublesome. These are listed in Table 2, but again only the species mentioned four or more times are included. This list is much shorter than that of Table 1, indicating that over a wide area there is a marked similarity in the important weeds of vegetable crops. This, in turn, suggests that there are certain conditions imposed by the cultivation of vegetables which tend to encourage a limited number of species at the expense of others.

Table 2

The Most Troublesome Annual Weeds of Vegetable Crops

(Arranged in the order of importance indicated by the inquiry)

Common Name	Scientific Name
Chickweed	*Stellaria media*
Annual nettle	*Urtica urens*
Fat-hen	*Chenopodium album*
Annual meadow grass	*Poa annua*
Redshank	*Polygonum persicaria*

Chickweed appears as the most serious weed, followed closely by annual nettle, while fat-hen and annual meadow grass are also important. That these four species are also the most frequent may be seen from Table 1. Other species, such as groundsel, shepherd's purse and the speedwells, though common, are not considered to present serious problems. There is, of course, some variation in importance of the common species from area to area, associated with climatic and soil differences. Thus redshank presents a particularly serious problem on the fen soils and in the north and west, while black nightshade is most troublesome in the south and east. Various other less common species may attain local prominence in areas where conditions are especially favourable to their development, and a special case is presented by the introduced species, Kew-weed (*Galinsoga parviflora*), which has become a problem in market gardens in Surrey.

Perennial Weeds

On land which is regularly cropped with vegetables, perennial weeds are not generally considered to be a serious problem, provided the various cultural operations are carried out efficiently. However, they may be serious in particular areas and are often troublesome on land which is in the process of conversion to vegetable production. Unless they are checked, there is always a tendency, too, for such weeds to invade from headlands. Perennial weeds assume a much greater importance when a crop occupies the land for a considerable period, as with asparagus, globe artichoke or rhubarb. Full cultivations cannot then be carried out, and these weeds, with their extensive underground systems, can flourish relatively undisturbed. The species occurring most frequently are listed in Table 3. Couch is by far the most troublesome, particularly on light soils, and horsetail is often associated with damp conditions.

Table 3

The Most Troublesome Perennial Weeds of Vegetable Crops

(Arranged in the order of importance indicated by the inquiry)

Common Name	Scientific Name
Couch	*Agropyron repens*
Bindweed	*Convolvulus arvensis*
Creeping thistle	*Cirsium arvense*
Horsetail	*Equisetum arvense*
Docks	*Rumex* spp.

Cultural Control

It is self-evident that serious weed problems can occur in nearly all crops when large populations of weed seeds are present in the soil and conditions are favourable to their germination and subsequent growth. But, due to the differences in growth habit, time of sowing or planting, and general cultural treatment between various crops, weeds tend to be more of a problem in some crops than in others. On the whole, the growers' worst difficulties occur with those crops which are direct-sown, and especially those, such as onion and beet, in which germination and seedling growth take place slowly. In these crops the weeds have an initial start on the crop, and though the weeds between the rows can be controlled by mechanical cultivation, removal of those growing in the rows necessitates the use of expensive hand labour.

A rather different, but again serious, problem occurs with peas, where frequently cultivations must cease at an early stage when the peas spread over between the rows. Tall, rapidly-growing weeds, like fat-hen, can then grow ahead, and late-germinating weeds may also develop unchecked.

The weed problem may vary considerably with one crop when this is sown at different times of the year, since many weeds exhibit a seasonal periodicity of germination. Thus chickweed and annual meadow grass are often serious nuisances in autumn-sown onions and lettuce, whereas other species, such as fat-hen and annual nettle, may form the problem in spring sowings of the same crops. Cultivation is usually difficult in autumn-sown crops because of the condition of the land, and many weeds may root again on the soil surface. Rooting of weeds after hoeing is always a danger when moist conditions prevail, and in some areas, such as Cornwall, where inter-row cultivation may be attended by this difficulty at all periods of the year, the weed growth has to be raked up and carted off. Annual meadow grass is particularly liable to root again after being hoed or pulled up, by reason of the quantities of soil retained among the dense fibrous roots, while chickweed and some speedwells (for example, *Veronica persica*) can form adventitious roots at the nodes of the creeping stems.

Transplanted crops, such as the brassicas, do not generally present serious weed problems. If planted on the square, as with Brussels sprouts, mechanical cultivation can be carried out both ways during the early stages of growth, and later the dense canopy formed by the

crop tends to prevent vigorous weed growth. Problems may arise if plants are set out close together within the rows, as with spring cabbage. When, as frequently happens, a dense stand of weeds develops in the early stages before the canopy is formed, hand cultivation may be the only solution.

It appears that many growers, very rightly, rely for their success in weed control on the orthodox cultivations well carried out. Proper rotation of crops is probably important also in keeping down the population of weed seeds in the soil, and some growers find that the inclusion of short-term leys in their rotations is helpful. The importance of reducing the weed seed content of the surface layers of the soil is widely recognized, and many growers try to induce the germination of as many weeds as possible before sowing the crops by an early preparation of the seedbeds, followed by harrowing to destroy the growing weed seedlings. A similar principle is involved in the practice of raising several crops of a rapidly-maturing crop like radish in preparation for, say, lettuce to be sown in the autumn. In the North Riding of Yorkshire special methods have been developed for cultural weed control in carrots. Seed is sown rather deeply on ridges, and before the carrots emerge the tops of the ridges are skimmed off, thus destroying the seedling weeds germinating in the surface layer. Skimming is also used to destroy fat-hen between the rows. In Lancashire shallow ploughing up to the rows is carried out with peas and other crops. For the control of couch, deep ploughing has been found effective in some areas, and in others rotary cultivation is used with a considerable measure of success.

Chemical Control

During the last decade there have been great advances in the chemical control of plant growth. To date, however, the vegetable grower has not benefited from research and development work in the herbicide field to anything like the same extent as the farmer, since most of the work in this country has been concentrated on producing effective herbicides for cereals and grassland. Unfortunately, too, the majority of vegetable crops are themselves susceptible to the chemicals available for these purposes. Nevertheless, there is a limited number of chemical control methods for vegetable crops, and one of the objects of the present inquiry was to gain some impression as to how widely they are in use, and how far they meet with the satisfaction of growers. The main points arising are briefly discussed below.

Sulphuric Acid

This chemical has been in use for some years for the control of weeds in onions and, to a lesser extent, in leeks. Most growers are aware of the method, and recommendations for the various circumstances have appeared in official publications. Sulphuric acid is an effective herbicide with no residual toxicity in the soil, and has the advantage

that it may be applied before the onions emerge (pre-emergence) or after they have " straightened up ". These advantages are offset by the corrosive nature of the chemical, which necessitates special spraying equipment, protective clothing and great care. Because of the capital outlay required, there is a tendency for the sulphuric acid method to be restricted to the larger grower. As onions are one of the crops which otherwise require hand weeding, growers would welcome an alternative chemical to sulphuric acid.

Mineral Oils

Since the discovery that certain types of light mineral oil would kill selectively many annual weeds in carrot crops, there has been a rapid increase in the use of this method. Initially, some growers were discouraged by instances of crop injury when vaporizing oils were applied. It was then shown that such oils often differed in their phytotoxicity from batch to batch, and growers were recommended to test them on a small patch before spraying a large area. Proprietary brands of oil are now on the market which are standardized specially for the purpose. Spraying, either with such oils or with ordinary tractor vaporizing oils, is now widespread, and a high proportion of the total carrot acreage is so treated—a proportion which is increasing from year to year. With suitable precautions the method is applicable to both maincrop and bunching carrots in the field, and is used with great success in some areas, such as the East Riding of Yorkshire, for early frame carrots. There seems to be no doubt that growers are well satisfied with this way of controlling weeds.

Certain other umbelliferous crops have also proved relatively resistant to applications of mineral oils. Crops of parsnips are treated to a limited extent and a few growers have used oils successfully to control weeds in parsley. There have been instances of the use of oils in self-blanching celery, though here there is a greater risk of injury, particularly if drought is allowed to intervene.

Dinoseb (Ammonium dinitro-butylphenate)

In the eight years since the discovery of this herbicide there have been extensive developments in its use for weed control in pea crops. Dinoseb (DNBP) sprays are now used on large acreages of threshing peas, and to a lesser extent on canning peas. However, the results of the present inquiry indicate that dinoseb has only a very limited use for market peas, probably for two reasons. First, the varieties grown for picking green seem, in the main, to be more susceptible than those grown for drying or vining ; secondly, with market peas any slight check to growth can be very important, as it may mean that the crop misses the early market. On the whole, therefore, dinoseb sprays are regarded by the growers as being a bit risky for market peas, though there is great interest, since peas are a difficult crop to keep clean by cultivation.

Other Chemicals

Apart from the instances mentioned above, there are no other chemical control methods for vegetable crops which can be said to have passed the experimental stage in this country. One method which has received a certain amount of attention, however, is the spraying of beet with strong solutions of nitrate of soda. Beet is more tolerant of high concentrations of sodium salts than are many annual weeds and, from time to time, sprays of common salt, nitrate of soda, or mixtures of the two, have been tried by growers. Some experimental work has also been carried out. The general impression seems to be that the degree of weed control attained is usually unsatisfactory, and there are some weeds, like fat-hen and other members of the Chenopodiaceae, which are unharmed by the sprays. Recently, several growers in Lancashire have reported good results using nitrate of soda, provided that attention is paid to such factors as volume rate, use of wetting agents and weather at the time of spraying. Further experimental investigation would seem to be desirable.

The present inquiry shows that several other methods of weed control have been tested at various times by progressive growers. Among them may be noted sodium cyanate and potassium cyanate as sprays for onions, calcium cyanamide for asparagus, and formulations of cresylic acids, both for seedbeds and for pre-emergence weed control in slow-germinating crops. The flame-gun is in limited use, some growers finding it useful for seedbeds and for pre-emergence control in such crops as onions. But none of these methods has yet gained wide acceptance among growers.

Conclusions

It is evident from this inquiry that in vegetable crops of short duration it is only annual weeds which are of any general importance, and that there is a striking similarity in the principal weeds of vegetable holdings over wide areas of England and Wales. Chickweed is considered the most troublesome, followed closely by annual nettle, fat-hen and annual meadow grass. The first and last of these four are particularly serious in autumn-sown crops. Perennial weeds are most serious in perennial crops such as asparagus.

Weed problems can occur in most vegetable crops but are more acute in crops like onions, beet, carrots and peas. For weed control, many growers rely on orthodox cultivations, proper crop rotation and on the production of "stale" seedbeds; that is, they attempt to germinate the weeds before sowing by early seedbed preparation, and kill the weed seedlings by subsequent harrowing. Special methods have been developed in some areas to meet particular circumstances, but it is probable that lack of knowledge of the behaviour of the weeds themselves constitutes an obstacle to further developments in this direction. The information obtained in the second part of the inquiry indicates that few chemical methods for weed control in vegetable crops are at present

in general use, and that of these only the use of mineral oils for carrots (and to a lesser extent other umbelliferous crops) is considered really satisfactory by growers. The others involve too great an expenditure, too great a risk of crop injury, or do not control the weeds to a sufficient degree.

The inference to be drawn from the results of this inquiry is that there is much scope for improvement of methods for controlling weeds in vegetable crops. The ultimate aim is reduction of the weed seed content of the soil, and with greater knowledge of the behaviour of the different weed species it may eventually be possible to improve existing cultural methods or to suggest new ones to further this end. This calls for ecological research, which must, of necessity, be continued over a number of years before practical suggestions can be developed from the knowledge gained. There is a possibility of more immediate benefit to the grower from research on chemical methods of weed control; there is great interest in this aspect and a considerable demand for such methods in many crops. Although it is true that new chemicals with herbicidal properties are continually being discovered, it is only after very thorough and extensive testing that their value to the grower can be assessed.

Thanks are due to the Horticulture Officers of the N.A.A.S. for their valued co-operation in furnishing information which has been incorporated in this article.

SYSTEMIC INSECTICIDES

J. T. Martin

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Considerable advances have been made during the past ten years in crop protection practice. Potent new insecticides, such as DDT, BHC and parathion, exerting their action by contact with the insect on the plant surface, were discovered and are now widely used for the control of many important pests. The most interesting development, however, has undoubtedly been the introduction of the systemic insecticide.

A systemic insecticide is one which, when applied to the roots or aerial portions of a plant, is absorbed and translocated to all parts of the plant, rendering it toxic to insects feeding upon it. Plant pathologists have long been intrigued by the possibility of inducing plants to take up chemicals for their protection. In 1929, Davidson and Henson described their work at Rothamsted on the effect of pyridine solutions on infested bean plants as an attempt " to induce the plant to take up and absorb into its tissues traces of certain chemical substances which, although innocuous to the plant concerned, would by

their presence render it unsuited or even toxic to the insects infesting it." Some of the naturally-occurring insecticides may show to a slight extent the property of movement through plants : sodium fluoroacetate, a toxin present in a South African plant, exhibits a marked systemic effect. The observation that wheat grown on seleniferous soils was not attacked by aphids prompted the use of sodium selenate as a systemic insecticide and acaricide, but the dangerous nature of selenium to man led to a vigorous discouragement of this practice. A major advance came during the early years of the war, when a new class of compounds possessing systemic insecticidal action of a high order was discovered.

The Modern Systemics

Between 1939 and 1941 Schrader, working in Germany with the entomologist Kükenthal, found that among the organic phosphorus and fluorine compounds they had synthesized were some showing marked systemic properties [1]. McCombie and Saunders at Cambridge also investigated similar compounds during the war years. After the war, a systemic organo-phosphorus insecticide, now known as schradan (in tribute to Schrader), was marketed in this country, and an account of its properties was given by Ripper, Greenslade and Hartley [2]. Two other compounds, each containing phosphorus and fluorine and now known as dimefox and mipafox, were also developed for crop protection purposes. Further research by Schrader [3] led to the discovery of other systemic compounds, one of which has come into commercial use. This is a phosphorus insecticide, for which the name demeton has been proposed. More recently, systemic heterocyclic carbamates, of interest from the fact that they contain neither phosphorus nor fluorine in their molecules, have been introduced by workers in Switzerland. The properties of these materials, which are referred to in the literature as dimetan, pyrolan and isolan, have been described by Ferguson and Alexander [4]. Two other systemically-insecticidal phosphorus compounds have lately been reported from the U.S.A. [5].

The complex nature of many of the chemicals now used in crop protection has raised a need for simple nomenclature. In this country the derivation of common names has been undertaken by a committee, sponsored by the British Standards Institution, working in collaboration with official organizations overseas so that the names proposed may be accepted internationally. Thus schradan is the common name now generally adopted for the chemical octamethylpyrophosphoramide (or pyrophosphoric acid tetra(dimethylamide)); a closely-related active compound, triphosphoric acid penta(dimethylamide), also occurs in commercial schradan insecticides. Preparations of Schrader's most recent material, demeton, contains two active isomers, *O*,*O*-diethyl *O*-ethylmercaptoethyl thiophosphate and *O*,*O*-diethyl *S*-ethylmercaptoethyl thiophosphate, distinguished by the names of demeton-*O* and demeton-*S*. Dimefox is the accepted common name for bisdimethylaminofluorophosphine oxide, and mipafox that for fluorobis-

*iso*propylaminophosphine oxide. The materials have been marketed under well-known proprietary names, such as Pestox (schradan), Isopestox (mipafox), Hanane (dimefox with some schradan) and Systox (demeton). An account of the properties of these insecticides has recently been given by Ripper [6].

Movement in the Plant

Much work has been done in this country by Heath and his colleagues, W. A. L. David, Bennett and Thomas, who all used the radio-active tracer technique to follow the absorption, movement and breakdown of systemic insecticides within the plant.

Schradan is absorbed by roots less rapidly from soil than from a sand or water medium, and the speed of action in soil culture may depend upon the type of soil in which the plant is grown. In foliar application, some of the schradan is lost by evaporation immediately after spraying ; absorption takes place through the cuticle at a rate dependent upon the plant species and environmental conditions. The intensities of light and heat radiation greatly influence the uptake of the systemic ; young leaves are more absorptive than the older leaves. When it enters through the foliage, movement takes place mainly in an upward direction ; after root absorption, a more general distribution within the plant is obtained. The amount of schradan needed in plant tissue for a toxic effect has been determined. W. A. L. David has found that a concentration (of schradan) of about 50 parts per milllion is required for a complete kill of aphids on bean.

The compounds are slowly broken down in the plant and are further reduced by loss in guttation fluids, evaporation and by passage to the soil.

Application and Properties

To be effective, systemic insecticides must show insecticidal activities of a high order and cause no damage to the plant. They may be applied as foliage sprays, by watering the soil, by seed treatment, or by trunk injection or absorption. Application by burying soluble capsules containing the material in the vicinity of roots has also been used.

Some seeds (for example, pea) treated with a systemic by the slurry method will take up the insecticide, which then confers valuable protection on the seedlings. The fact that after absorption the systemic insecticide is carried to all parts of the plant ensures that regions missed by conventional spraying are reached and that hidden insects —for example, those sheltering in growing points or curled leaves—are controlled. Once absorbed, the insecticide is unaffected by weathering, and new growth, for which a second surface treatment would be required, is protected so long as the material persists in the plant at a toxic level. Considerable attention has been given recently to the effect of spray chemicals upon beneficial insects. The systemic insecticides

now in use show, to a varying degree, a contact insecticidal action, but the fact that when once inside the plant they affect mainly sucking insects confers a measure of protection upon useful species. Because of this, interest has been taken in the use of the materials in supplementing the natural biological control of pests. Very few cases of a deleterious effect upon plants have been reported.

Field Uses

Considerable information has accumulated on the protection afforded by the systemics when used on crops. Among the pests most easily controlled are aphids, Red Spider mites and scale insects. Promising results have also been obtained in the control of some plant-infesting nematodes.

Reports from many parts of the world show the value of systemics for the protection of crops such as pea, brassicas, hop, apple, plum, cherry, peach, strawberry, gooseberry, tobacco, citrus, coffee, sugar cane and ornamentals. Many instances of the successful use of schradan and demeton have been recorded, while dimefox has found a special application in the control of the vector of the swollen shoot disease of cacao. Large-scale tests of the use of systemics in horticulture have been carried out by the European authorities. In Norway, pre-blossom and post-blossom applications of schradan and demeton gave excellent control of spider mites, Green and Rosy Apple aphids and Mealy Plum aphids on top fruit. No reductions were observed in the populations of predacious insects.

In this country, early work by Ripper and his colleagues showed that schradan gave excellent control of aphids and red spiders on a wide range of crops, including brassicas, sugar beet, bean, hop, pea, apple and ornamentals. Dicker at East Malling has used schradan effectively for the control of Strawberry aphids. He recommends that runner beds or de-blossomed maidens should be sprayed in late May and early July, but that fruiting beds should not be sprayed within six weeks of picking. He found that the runners of strawberry plants became toxic to feeding aphids after treatment of the parent plant, an interesting example of the translocation of the insecticide. Potter and his colleagues at Rothamsted have included demeton and mipafox in trials with other insecticides on the control of bean aphids on field beans. The systemics performed well and the yield of seed following the treatments was greatly increased. Wright and Wheatley at Wellesbourne have compared the effects of schradan and other insecticides in controlling the Cabbage aphid, *Brevicoryne brassicae* L. Effective control was obtained with schradan by both foliage and soil application, and the insecticide restrained the multiplication of aphids in the hearts of the treated plants for two months. Systemics have already been used on a wide scale for the control of aphids on Brussels sprouts.

The persistence of the systemics and the protection afforded to new growth after spraying, has focused attention on their possible value in the control of virus diseases of plants. Work so far reported from Rothamsted on the control of the Leaf Roll disease of potatoes has indicated little correlation between the reduction of the aphid vector population and the limitation in the spread of the disease. In other work on the Cauliflower Mosaic and Cabbage Black Ringspot diseases, schradan, demeton and pyrolan were included in treatments designed to control the aphid vectors, but none of the insecticides produced any significant reduction in infection. Hull and Gates have carried out extensive field trials with insecticides, including schradan and dimefox, on the control of the beet yellows virus in sugar beet. They obtained a greater reduction in the incidence of yellows with the systemic and the persistent contact phosphorus sprays than with nicotine. The effect was obtained by clearing the stecklings of aphids after autumn migration had ceased, thus preventing the spread of the disease during the winter. They conclude that, although spraying often greatly reduces the incidence of the Sugar Beet Virus Yellows disease, it is unlikely to give adequate control in years and in districts in which many virus-carrying aphids move in the autumn.

Read of Cheshunt has reviewed the use of systemic insecticides in glasshouse practice. The acaricidal effects of schradan, dimefox and mipafox applied to roots or leaves have been confirmed, but the risk of damage to plants may limit the use of dimefox. The time of application and the method used need to be suited to the plant; for example, schradan applied to the soil gives excellent control of Red Spider mites and aphids on carnations during spring and summer, but fails to do so during the winter. The systemics are likely to find wide application in flower culture, but more investigation is necessary, and it has yet to be determined whether the existing ones will be applicable to the two main glasshouse crops—tomatoes and cucumbers.

Toxicology

The systemic insecticides are toxic to mammals. The individual toxicities of schradan, dimefox, mipafox and demeton vary, but the levels of toxic action are indicated by median lethal doses to rats, by intra-peritoneal administration, of the order of 5-25 mg./kg. Dimetan and pyrolan exhibit lower mammalian toxicities than isolan, but their systemic insecticidal properties are not so marked. The compounds may be absorbed by the mouth, through the skin and by inhalation. No cases of poisoning following spraying have arisen in this country, and long-lasting chronic effects have so far been reported only in two cases of accidental poisoning with mipafox. The systemic compounds now used are subject to the Agriculture (Poisonous Substances) Regulations of 1953, and statutory requirements are in force concerning the precautionary measures to be taken by spray operators.

The mammalian toxicities of the systemics and the degree of persistence they show in plants have raised the possibility of hazards to the consumers of treated crops if the time between the application of the materials and harvesting is too short. A considerable amount of work has already been carried out in this country on the rate of breakdown of schradan in plants, using both chemical methods and the radioactive tracer technique. A. David and his colleagues [7], in chemical work, determined the amounts persisting at harvest time in strawberries sprayed in early May and in hops sprayed in mid-June. Maximum values of the order of 1 and 2 parts per million were recorded. The work was repeated using radio-active schradan and extended to the examination of sugar beet and Brussels sprouts [8]. Sugar beet, sprayed at the end of July, contained less than 1 p.p.m. thirty days later. In the treatment of Brussels sprouts, the time of year at which they were sprayed had a marked effect. The sprouts from plants sprayed in August contained, one month later, 2-3 p.p.m. of schradan and slightly lower amounts of the penta(dimethylamide) compound; those from plants sprayed in October contained appreciably higher amounts. Dicker has also observed an increased persistence of schradan in the strawberry plant during the early winter period. Heath and his colleagues found that the rate of breakdown of schradan, under summer conditions, was independent of the species of plant with which they worked; Thomas and Bennett, working at Long Ashton with other species under different experimental conditions from those of Heath, observed differences in the breakdown rate of schradan. Thomas, in collaboration with Glynne Jones, has also observed the contamination of nectar by schradan, with the risk of its transmission to honey.

From experiences in the field, combined with toxicological considerations, Ripper [6] has suggested maximum tolerances, in vegetables and fruit, of 3 p.p.m. schradan, 0.2 p.p.m. dimefox and 1 p.p.m. mipafox. He has also proposed minimum periods between spraying crops, such as strawberries and Brussels sprouts, and harvesting. These periods extend from four weeks, if the material is applied between April and July, to eight weeks, if application is made in November. There is every indication from the information available on residue levels, from the limited number of animal feeding trials carried out and from experience in its administration to humans, that no consumer hazard from schradan is likely to arise if these minimum periods are adhered to. The use of systemics in relation to consumer hazards has been reviewed by the Working Party on Toxic Chemicals in Agriculture [9], which has drawn attention to the need for more data on the amount and persistence of the materials in different crops under different conditions, for the dissemination of information and for the correct use of the materials by the grower.

Much interesting biochemical work has been carried out on the metabolism of schradan in plants, insects and mammals. In common with other organo-phosphorus insecticides, it exerts its toxic effect

by the inhibition of cholinesterase and other enzymes. Early work showed that schradan itself was a weak inhibitor of cholinesterase, and that mild oxidation greatly enhanced its activity. It is now known that schradan, after absorption by the plant, insect or mammal, is metabolized to form a highly active enzyme inhibitor. In mammals the change takes place in the liver. Recent work in the U.S.A. has indicated that the product of the conversion is a phosphoramide oxide, and that the reaction is brought about by a widely-distributed enzyme system, termed phosphoramide oxidase. The pronounced systemic-insecticidal activity of demeton, which has a low solubility in water, is similarly explained by its ready conversion, in plant tissue, into soluble and highly toxic substances.

The systemic insecticides thus show great potentialities in the control of pests, and their introduction undoubtedly marks the beginning of an important new stage in the development of the science of crop protection. Other compounds, desirably of high insecticidal activity and low mammalian toxicity, are likely to be forthcoming : in the meantime, investigations on our present systemics should be extended and every care taken to ensure that they are used intelligently.

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ABSTRACTS

ANIMAL BREEDING

Heritability of Gain in Different Growth Periods in Swine. C. T. Blunn, G. N. Baker and L. E. Hansson. *J. Anim. Sci.*, 1953, **12**, 39-50.

The relative importance of factors affecting the rate of gain from birth to slaughter in pigs—a trait of direct interest to the farmer—has been studied in this paper. For the purpose of the analysis, the growth period has been divided into three periods according to the time at which pigs in experimental herds are weighed : in the present case, at birth, 56 days (weaning), 112 days and 154 days. The variation due to differences between seasons, lines, sires in lines, litters by the same sire, and variation within litters, have been assessed. With this information the effect of inheritance, the influence of the sow on the growth of her litter, the environmental variation peculiar to individual pigs, and the variation in phenotype have also been measured. The percentage contribution of each factor to variation in rate of gain in the three growth periods for two herds studied is given in the table.

	North Platte Herd			Lincoln Herd		
	Period			*Period*		
	1	2	3	1	2	3
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Genetic	22	51	25	3	35	34
Influence of sow ..	10	14	15	40	18	8
Individual's environment	68	3	60	57	47	58

The rate of gain from weaning to 112 days is seen to be controlled by inherited factors to a greater extent than gain up to weaning or during the final stages of fattening, whilst the influence of the sow was surprisingly small in the period before weaning in the North Platte herd. The authors offer no explanation.

Knowledge of gains over arbitrary periods of time may be of value in determining the best time to select replacement animals. The authors concluded that pre-weaning gain in weight is not a reliable basis of selection and that growth in the second period is a better measure than that in the last stages of fattening. Gain in the second period is measured before puberty and is not influenced by the onset of ranting in the boars, which frequently causes temporary loss in weight. Growth is largely in bone and muscle rather than fat ; selection at 112 days should therefore emphasize leanness. This criterion also has the advantage of being available relatively early.

Breed Structure in the Pedigree Ayrshire Cattle Population in Great Britain. G. Wiener. *J. agric. Sci.*, 1953, **43,** 123-30.

Growth of the Pedigree Ayrshire Cattle Population in Great Britain. G. Wiener and T. S. Yao. *Emp. J. exp. Agric.*, 1952, **20,** 195-208.

Between 1943 and 1946 the number of females registered in the Ayrshire herd book almost doubled, increasing from 14,493 to 24,670. The growth of the breed from its early days to the present, the way in which its expansion occurred and the effect this has had on the structure of the breed are dealt with in these studies.

By taking a random sample of 100 females registered in 1946 and tracing back the male side of their pedigrees over four generations, Wiener is able to show the dominant role played by eight herds. He estimates their genetic contribution to the 100 pedigrees at 45 per cent, or 10 per cent per generation. Two herds stand out from the rest for the size of their contribution. Having established the importance of eight herds as suppliers of bulls to the breed, the pedigrees of 1,000 males registered by them during a six-year period up to 1946 were examined. Fifty to sixty bulls dominated these pedigrees and may thus be regarded as the most important sires in the breed.

The expansion of the breed has not resulted in an increase in the number of top herds. The tight hold of a small group of breeders has increased. In 1927, 2.6 per cent of herds bred the sires of 22.9 per cent of bulls entered in the herd book. In 1946, 1.5 per cent bred the sires of 25.8 per cent of bulls registered. Breeders in Ayrshire still register about a fifth of all females and a quarter of all males, and the pedigrees of bulls bred elsewhere trace back to this source after one or two generations. The large number of bulls required for breed expansion has been provided by an increase in the number and size of the " multipliers' " herds. The owners of these herds buy sires from the top herds to breed bulls for sale to the mass of pedigree breeders who, as a general rule, rear only heifer calves. The consequences of this development on breed structure is represented by a cone-like figure with curving sides, tapering towards the apex. The apex is occupied by the eight top herds from which all genes must come before spreading, by way of the multipliers' herds, through the breed as a whole.

The ratio of male to female registrations in 1946 was 1 to 1.3 among a group of 86 herds, which entered 28 per cent of all males in the herd book. This compared with 1 to 5.2 in the whole breed. Obviously, in these herds there can be but little selection of cows from which bull calves are to be reared. It is suggested that even if the best 20 per cent of cows in all herds were used to breed bulls, instead of nearly all cows in a few herds as at present, the genetic merit of the bulls bred would probably not be altered.

J.H.W.

Milk Marketing Board. Report of the Production Division. No. 3, 1952.

The third annual report of the production division of the Milk Marketing Board follows the now familiar pattern of its predecessors. It gives the usual statistics relating to the dairy industry in England and Wales, showing an increase in the average yield per cow, and a decrease in numbers of cows compared with 1950-51. Membership of the milk recording movement has remained substantially unaltered during the year.

The third stage of an investigation into the influence of age at first calving on total yield over four lactations shows that there is little such influence ; the range of first calving is 24-38 months. Previously (Report No. 1), it had been found that an early age at first calving reduced the first lactation yield ; it now appears that the initial reduction is made up over subsequent lactations. An investigation into the relationship of fat percentage to milk yield on 115,197 cows (second lactation and over) from five breeds shows an inverse ratio between the two.

Other sections deal with the artificial insemination statistics of the Board, investigations into diluents for bull semen, and preliminary trials into long-term storage of semen by deep freezing. This, if it becomes a standard practice, will open new and wide possibilities for A.I. in breeding plans.

Semen from Ayrshire bulls for crossing with Simmental cows, and Jersey semen for Brown Swiss cows, was flown to Switzerland for a cross-breeding experiment. Preliminary results show that, in the former cross, udder formation in young heifers was better than in the parent Simmental breed. The Jersey × Brown Swiss heifers were smaller, markedly finer in bone, and had better udders than their dams.

G.W.

Evidence of Gene-Controlled Sterility in Bulls. H. P. Donald and J. L. Hancock. *J. agric. Sci.*, 1953, **43**, 178.

A form of bull sterility, originally recognized in Holland, shows a variable but usually high proportion of spermatozoa, which are characterized by an abnormal formation of the acrosome. The majority of affected animals have been Friesians. Seventeen British animals were available for the present study, and the conclusion is drawn that the defect is due to an autosomal sex-limited recessive gene. Of the seventeen bulls, eleven were bred and reared in one herd, three in another, and one in each of three more herds. They were located by several observers over a period of six years, and, with four exceptions, were being used in herds other than those in which they were bred. One bull was imported and now has numerous descendants in Britain ; many of these, no doubt, are heterozygotes capable of producing sterile sons when mated together. However, as such a gene is gradually self-eliminating, and as breeders

concentrate their attention on more recent importations, the frequency of the gene and of affected bulls is likely to diminish rather than increase —unless, of course, it has been more recently re-imported. Whatever the actual position, it seems well worth while to examine Friesian bulls found to be sterile (especially those from prominent pedigree herds) in order to identify cases of knobbed sperm. Breeders would probably wish to take appropriate action if only to avoid a serious source of trouble and expense.

G.B.Y.

SOILS

Sodium as a Plant Nutrient. J. J. Lehr. *J. Sci. Fd. Agric.*, 1953, **4**, 460.

A recent analysis by Bertrand (*C.R. Acad. Sc. Paris*, 1951, 232, 1381) of different species of plant showed that they all contained sodium, varying from more than 10 grammes to less than 0.1 grammes of sodium per kilogram of dry matter. From results of most early experiments, sodium had always been regarded as beneficial in that it replaced potassium, and was completely dependent on the amount of potassium present. In many crops sodium can reduce or even prevent the occurrence of potassium deficiency, but a certain minimum of potassium is required or the addition of sodium will aggravate the symptoms of potassium deficiency.

The article includes illustrations of plants which show potassium deficiency when nitrogen is supplied as nitrate of lime, but not when Chilean nitrate of soda is used, as well as coloured illustrations of fodder beet showing potassium deficiency symptoms with dressings of muriate of potash, but no symptoms when Chilean nitrate of soda is used without potassium.

A diagrammatic classification of the needs of different crops for sodium, and the potassium inter-relationship of the crops, indicates the Chenopodiaceae as showing the largest response to sodium (where sodium is capable of replacing potassium to the greatest extent) : at the other end, maize, rye and swedes show no direct response to sodium and only a slight ability to use sodium in place of potassium. Reference is also made to recent literature in which it is suggested that sodium is essential for some crops.

Evidence from the estimation of potassium and sodium in oats and potatoes shows that oats and potatoes, which have a relatively low capacity to absorb sodium, can, even at very low levels, absorb potassium.

E.R.
W.M.D.

The Rate of Decomposition of Hoof-and-horn in Soil

In their studies of the rate of nitrification of various organic and inorganic nitrogenous manures, such as dried blood, sulphate of ammonia, hoof-and-horn, and bonemeal, Owen and his colleagues (*J. agric. Sci.*, 1950, **40,** 185 and this Review, 1951, No. 14, 81) have shown that the rates of nitrification in soil are higher than had previously been stated. Recently (*J. Sci. Fd. Agric.*, 1953, **4,** 415 and 423) they have examined hoof, horn, and mixtures of the two, to determine whether easily performed laboratory tests can give information on the rate of mineralization. Organic materials vary considerably in composition, because they come from so many different sources, are prone to biological decomposition on storage, and are processed by heating and grinding in various ways.

Comparison of seven samples of raw hoof, five of raw horn and ten of mixed, raw hoof-and-horn showed that their nitrogen content was remarkably constant, varying between 13.48 per cent and 15.72 per cent, with a mean of 14.78 per cent. Their physical state differed considerably in that the horn samples consisted of thin, tough fibrous strands. The percentages of particles passing through a 40-mesh sieve were : 6.0-45.5 for hoof, 0.3-37.5 for horn and 0.1-35.9 for mixed hoof-and-horn.

After milling the samples to a more uniform size, soil incubation tests were made to determine the rate of conversion of nitrogen to ammonia and nitrate. Over seven days there were marked differences between the materials—hoof being more readily decomposed than horn—but after ten weeks the differences were smoothed out over the whole series of materials, with a percentage mineralization range of 64-81 (mean 73.7 per cent). Determinations were also made of water-soluble nitrogen, hydrolysable nitrogen, bulk density, and sieve analysis for correlation with nitrifying properties, as was previously done with bonemeal (*J. Sci. Fd. Agric.*, 1951, **2,** 125 and this Review, 1951, No. 14, 82). Bulk density was found to be closely correlated with nitrifying properties, the correlation coefficient being significant at $P = 0.001$; this property is probably related to the amount of fibrous material present, especially in samples of horn.

At a similar level of significance, hydrolysable nitrogen (0.75 grm. hoof-and-horn autoclaved with 50 ml. 0.25 N. H_2SO_4 for 1 hour at a pressure of 15 lb./sq. in.) is correlated with the nitrifying rate. Comparison of decomposition rates of hoof and horn showed that the former is at first more quickly broken down in soil than the latter, but that after ten weeks there is relatively little variation.

Because of the difficulty of grinding or crushing such tough and fibrous materials as raw hoof-and-horn, much of the material sold for horticulture is heated by steam, or " calcined ". Examination of four samples of hoof, five of horn, and ten of mixed materials by soil incubation tests after grinding showed that they behaved very similarly to the raw

products. Over a period of ten weeks the amount nitrified ranged from 62 to 76 per cent of total nitrogen.

In addition to the soil incubation tests, samples were examined after milling for water-soluble nitrogen, distillation with an aqueous suspension of magnesium oxide, formol titration of aqueous extracts, bulk density and sieve analysis.

Heating increases the proportion of water-soluble nitrogen and has more effect on horn than hoof. This determination was very significantly correlated with soil incubation ($P = 0.001$), as also was the percentage nitrogen by formol titration. Bulk densities, as with raw materials, gave significant correlation.

Generally we may conclude that hoof-and-horn, whether raw or heat treated, forms a reasonably homogeneous class of fertilizer, and that any variations in initial rates of decomposition in soil do not persist for long and are considerably less than those shown by bone materials. Simple chemical and physical tests can be used to forecast the behaviour of any particular batches in soil.

Urea-Formaldehyde Materials as Nitrogenous Fertilizers

The chief contrast between organic and inorganic nitrogenous fertilizers has been that the latter usually provide nitrogen in a form more quickly available to plants than do the former, although, as has been shown by Owen and Hamence (see this Review, 1951, No. 14, 80, and 1952, No. 18, 252), the nitrogen in some materials, such as dried blood and some specimens of bonemeal, is converted into nitrate more readily than had been thought. The possibility of synthesis of a series of nitrogenous fertilizers having a controllable range of availability is attractive, especially to horticulturists. The urea-formaldehyde plastics seem to offer opportunities of this kind because urea itself, containing 46 per cent N, has a high availability—170 on Owen's scale, where dried blood equals 100.

Owen, Winsor and Long (*J. Sci. Fd. Agric.*, 1952, **3**, 531) have prepared a number of these materials and have determined the rate and degree of mineralization of the nitrogen in relation to the ratio of urea to formaldehyde before they have reacted chemically to produce the solid plastic. The conditions of manufacture, such as the *p*H at which reaction takes place, the temperatures of reaction, drying and storage, and the length of time of reaction, all influence the properties of the resulting product.

In this work, three different methods of manufacture were used. When urea and formaldehyde were mixed in proportions between 1 : 1 and 3 : 1 at a *p*H of 3.5, and heated after the initial reaction to 90°C. for twenty minutes, a series of products containing 35-43 per cent nitrogen were obtained. When equi-molecular quantities of urea and formaldehyde were used, the product was almost insoluble and inert in soil, but with

increasing proportion of urea the percentage of soluble nitrogen and mineralization steadily increased. The latter was determined by incubating samples with moist soil and analysing sub-samples at intervals. A material with a urea-formaldehyde ratio of 1.7 : 1 and having 48.9 per cent of its nitrogen in water-soluble form, behaved similarly to hoof-and-horn. High availability in soil followed the percentage of water-soluble nitrogen.

When materials prepared in the way described above were washed, more nitrogen was removed from the products as the urea-formaldehyde ratio of the reactants increased. Thus, while the urea-formaldehyde ratio of the products from mixing the reactants in a 1 : 1 ratio was 1.01 : 1, it was only 1.45 : 1 when the original reactants were mixed in the ratio of 3 : 1 urea-formaldehyde. Mineralization tests of the washed materials showed that there was a lag over the first fourteen days, but that thereafter the process was quick, and the final percentage nitrogen mineralized varied with the urea-formaldehyde ratio and was about 10 per cent less than that of the unwashed samples.

Tests on several batches showed that, for several ratios of the ingredients, products of reasonably consistent composition can be made. Preparation by mixing the ingredients at 50°C. and holding at 40° C. for twenty-four hours before filtering off the product, or by mixing them without heating above 25°C. (especially by the latter method), gave materials with a relatively high availability in soil. And these materials did not depend upon a high content of unreacted urea and initially soluble constituents.

The writers emphasize that the distinction between soluble and insoluble constituents in urea-formaldehyde samples is an arbitrary one, because the materials are complex mixtures of uncertain composition and may undergo hydrolysis in water.

The materials go some way towards the synthesis of nitrogenous fertilizers with controllable rates of nitrification. The initial rate can be varied by controlling the content of soluble constituents in the product, while the less soluble constituents remain almost inert for a period and then nitrify comparatively quickly.

J. B. E. P.
W. M. D.

HERBAGE

Some Aspects on the Irrigation of Temporary Leys (Parts I and II). Gösta Julén, *Acta. agric. Scand.*, 1952, **11,** 312-39.

The response of growing plants to irrigation is conditioned by certain climatic factors other than the prevailing moisture condition. A study of these factors was made on certain irrigated and un-irrigated leys, including pure lucerne, lucerne mixtures, red clover mixtures, white clover mixtures and reed canary grass. When irrigation produced a marked increase of growth, a positive correlation was shown to exist between growth and hours of sunshine, while a negative correlation occurred between growth and temperature. However, at seasons of the year when no growth response is obtained by irrigation—that is, when the moisture supply is abundant—growth tends to be positively correlated with temperature. The influence of the different factors upon the growth rate was similar in all types of leys in the experiment. Thus during early spring, when there is plenty of moisture, increasing temperature and light result in increased growth. Since, under natural conditions, increasing light intensity or sunshine and temperature are concomitant, the negative effect of temperature on growth when moisture is limiting is not observable. A perfectly balanced irrigation routine makes it possible to utilize the positive effect of light and to counteract the negative effect of high temperature in periods of strong sunshine.

Enårige Forsøg med Kunsteg Vanding of Markafgrøder. F. Heick. *Tidsskr. Planteavl*, 1952, **55,** 433-48.

The effect of sprinkler irrigation on the yield of red clover-grass mixtures, amongst other field crops, was studied over a five-year period. The rainfall was supplemented up to 60, 80, 100 and 120 mm. of water during the four months from May to August, respectively. The mean precipitation for the five years during these months was 44, 48, 82 and 95 mm. and the mean annual application of water amounted to 117 mm. Two cuts of forage were taken each year, and without irrigation the annual mean yield was 4,700 kg. of dry matter, containing 764 kg. of crude protein per hectare. With irrigation, the mean yield was 7,900 kg. of dry matter containing 1,354 kg. of crude protein per hectare, representing a 68 and 77 per cent increase in the yield of dry matter and crude protein, respectively. The greater proportional increase in crude protein was attributed to the higher proportion of clover in the irrigated herbage.

The Effect of Ground Water-level upon Productivity and Composition of Fenland Grass (II). H. H. Nicholson *et al.*, *J. agric. Sci.*, 1953, **43,** 265-74.

This investigation first carried out in 1949, which was one of the driest years on record, was repeated in 1950. (See this Review, 1952, No. 16, 160-1). By contrast, 1950 was abnormally wet, but, nevertheless,

the effect on the growth of Italian ryegrass in its seeding year of high, medium and low soil water-levels (18, 23 and 30 inches respectively below the soil surface) were similar to those of the previous year. Soil water at 18 inches was deleterious to the yield and protein content of the grass, and also reduced the content of Mg and K. There was no consistent effect on Ca or P content.

As a result of previous cropping history, the effect of the various soil water-levels were studied at two fertility rates, but the results were apparently unaffected by the soil nutrient status.

The difference in grass yield and other characters with soil water at 23 and 30 inches below the surface were not sufficient to indicate the optimum water-level. There was a suggestion that the optimum level may be between these levels, but evidence was not considered sufficient to warrant such a conclusion.

The Effect of Rabbit Grazing on a Reseeded Pasture. Winifred M. Phillips. *J. Brit. Grassl. Soc.*, 1953, **8**, 169-81.

The damage inflicted by rabbits on a reseeded pasture was studied for fifteen months after sowing. In the early establishment phase, unequal pressure of rabbit grazing on the experimental plots showed that early grazing caused a very marked reduction in the establishment of the palatable sown grasses. Where heavy rabbit grazing had occurred from the time of sowing, herbage yield by the autumn had been reduced to 43 per cent of the control plots. The winter pressure of rabbits was evenly distributed over all the rabbit-grazed plots, and the spring yield of herbage was from 36 per cent to 39 per cent of the control plots. The selective grazing of the rabbits bore heavily on the palatable sown species, being heaviest on Italian ryegrass, followed by perennial ryegrass, clover and rape in that order. Where grazing by rabbits had been heavy from the early establishment phase, there was an increase in the proportion of unsown grasses and weeds.

During the fifteen months rabbit grazing reduced the herbage yield of all plots by 60 per cent. On the various plots the yield of ryegrass was reduced by 66-84 per cent, clover by 22-77 per cent, unsown grasses by 76-85 per cent, while weeds increased by 21-70 per cent. The effect was clearly reflected in the total liveweight increase of lambs grazing the pasture, which fell from 521 lb. on the protected plots to 263 lb. on the rabbit-grazed plots.

T.E.W.

A CORN EXCHANGE STAND FOR ADVISORY WORK

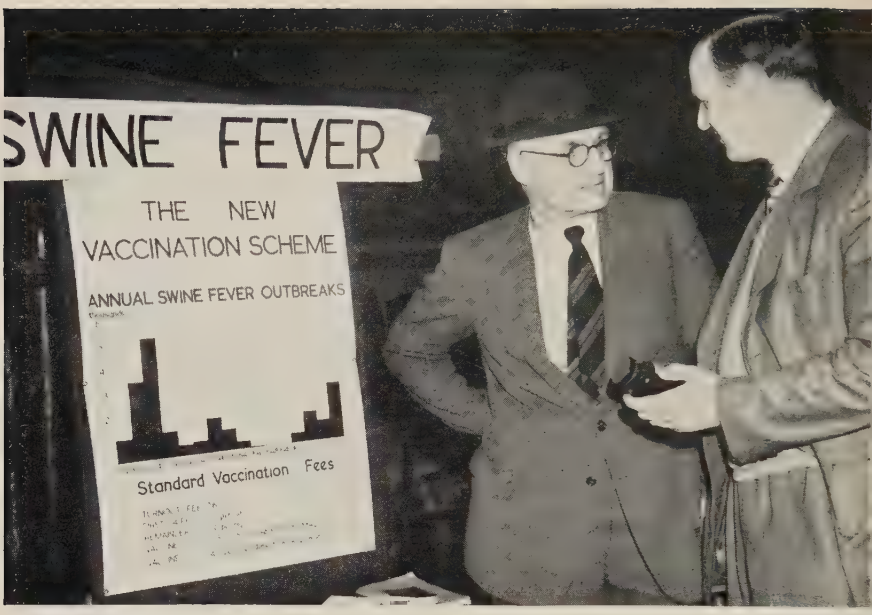
(see pp. 182-4)

A busy scene in the Lincoln Corn Exchange.

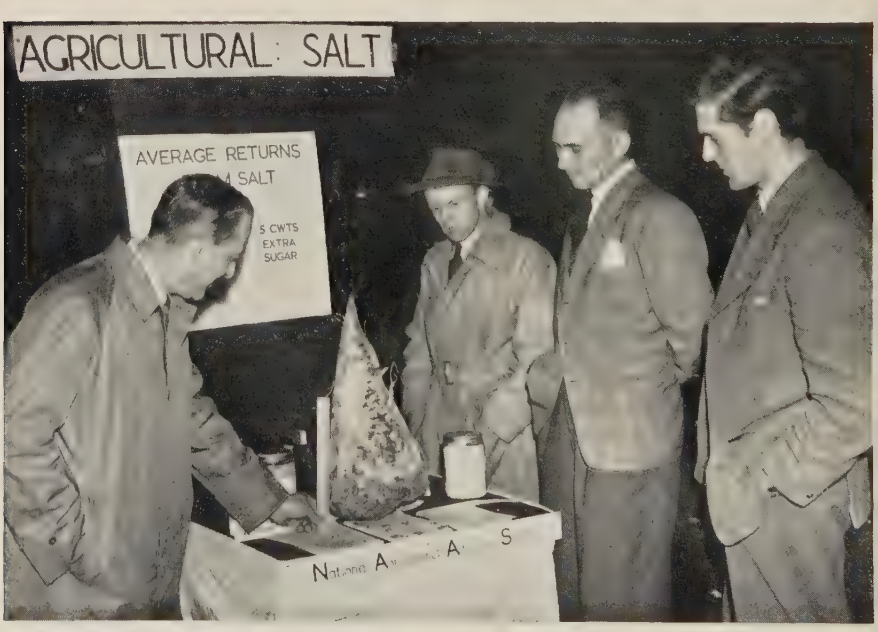
Photographs: *Lincolnshire Echo*

The N.I.A.B. supplied samples of grain and specimen ears of recommended varieties.

PLATE I



"Live" material must sometimes give way to diagrams and printed matter.



Photographs: *Lincolnshire Echo*

A bold, simple layout is the aim.

PLATE II

CROP HUSBANDRY

The Grazing of Cereals

The effect of defoliating cereals in spring has received attention in this country during recent years, and Peto (*Fmr and Stk-Breed.*, 1954, February 9-10, 59) has summarized the practical implications of the procedure. A paper by M. A. Sprague, " The Effect of Grazing Management on Forage and Grain Production from Rye, Wheat and Oats " (*Agron. J.*, 1954, **46,** 29-33) gives details of some experiments conducted at New Brunswick, New Jersey, between 1947 and 1951, in which separate areas on each of four replicate plots of each grain were managed as follows : (1) grazed in the autumn ; (2) grazed in the spring ; (3) grazed during both the autumn and the spring ; (4) no grazing at all. Autumn grazing began thirty days after planting, when the forage was 5-7 inches high, and continued for 3½ weeks. Spring grazing began about April 1, when the forage was 6-8 inches high, and continued for 2 weeks. Grazing stopped in both cases when the top growth was eaten down to about 2 inches, or, in spring, as soon as the stems began to elongate. Spring grazing caused the grain yield of both wheat and rye to be only about 70 per cent of that from ungrazed plots. It lowered the yield of straw by nearly 40 per cent, but it also reduced lodging, which on the ungrazed plots varied from 60 to 100 per cent. Grazing only in the autumn increased grain yield by 11-19 per cent : this may be due in part to the delay in inter-nodal elongation in spring, which is a consequence of autumn grazing. Autumn grazing followed by spring grazing resulted in better yields of grain than spring grazing alone.

The amount of pasturage provided was considerable. Rye, when grazed for 6 weeks in the autumn and 3 weeks in the spring, provided 3,043 lb. of dry matter per acre : this was the equivalent of 75 per cent of the three-year average production of a fertilized Kentucky blue grass—white clover pasture on the field used in this study in 1950-51. Wheat provided 1,911 lb. of dry matter per acre ; winter oats yielded only 940 lb.

Spring dressings of nitrogen were not applied, though the report suggests that they could probably be used to advantage.

On the morphological side, spring grazing reduced the number of productive tillers, but autumn grazing had little effect. The average number of mature seeds per head and the total weight of seeds per head were increased by grazing, and the weight per bushel of wheat and rye was consistently increased by grazing in the autumn. In wheat and rye, autumn grazing delayed inter-nodal elongation in the spring.

A paper by C. Thakur and H. L. Shands (Response of Small Grain to Plant Clipping. *ibid.*, 1954, **46,** 15-9) reports that spring-sown barley, oats and wheat, when " clipped " in spring, showed reduced grain yields and reduction in height, length of ear, stem and root diameter, etc. Unfortunately, this paper is of little practical value in Great Britain. No

information is given of the stage of growth when the clipping took place ; it is stated that in 1948 " the plants were cut back to a height of 8 inches on June 14. In 1949, they were clipped twice, the first clipping being made on May 27, and the second on June 2. Plants were cut back to a height of 3-4 inches." It is clear that the conditions described were quite different from those which interest us in the early spring grazing of winter-sown cereals.

Potatoes

Reference was made in this Review (1953, **22,** 73-4) to a paper by Wilson and Dawson, who reported that after 4-5 months' storage, the amount of tetrachloronitrobenzene (TCNB) remaining in ware tubers dusted with a proprietary sprout depressant was of the order of two parts per million. Wilson and Harries (*J. Sci. Fd. Agric.*, 1954, **5,** 80-5) have now reported upon " The Flavour of Potatoes Treated with Tetrachloronitrobenzene and Iso-Propyl N-Phenylcarbamate ". The tests were undertaken during the 1950-51 storage season, and were conducted upon several different varieties of potatoes stored in clamps. Very careful examinations were made for flavour, both by test panels and by consumer acceptance tests. The conclusions reached were " that no detectable taint followed the use of IPC, whereas treatment with TCNB led to a slight but significant reduction in flavour quality, although by no means all treated samples were downgraded below corresponding untreated control samples . . . The result of the consumer acceptance test suggests that the average level of off-flavour found in the panel tests withTCNB-treated tubers would not normally be detected by most persons when potatoes are eaten as part of a meal."

Turnips and Swedes

An article " Turnips and Swedes for New Zealand Conditions ", by J. O. Wallace (*N.Z. J. Agric.*, 1953, **87,** 337) explains how the very large number of root varieties formerly offered for sale has been reduced to a Government-approved list of six varieties of swedes, seven varieties of yellow-fleshed turnips, and four varieties of white-fleshed turnips. Typical specimens are reproduced in a double-page colour feature. Supplies of seed of Government-approved varieties are distributed to the New Zealand seed trade in clearly marked 1 lb. and 2 lb. calico bags. The distributing firm is responsible under departmental supervision for the growing of commercial seed supplied from nucleus stocks raised by the Department of Agriculture. Cleaning, blending and packeting of the seed are also done under departmental supervision, and, after filling, the bags are sewn with a lock-stitch and marked with a departmental stamp.

G. E. F.
D. H. R.

MACHINERY

Planning a Farm for Higher Productivity. *University of Cambridge, School of Agriculture Farm Economics Branch Report* No. 41, 1954.

This report illustrates the application of the technique of " budgeting " to an investigation of the effects of mechanization on the labour force of the farm as a whole, and deals with the adjustments in farm management policy needed to make the best use of specified advances in mechanization on a selected farm. It is a technique which has been used in the United States, both for research and advisory purposes, and is similar to one which has been introduced successfully on a limited scale in advisory work in Germany.

The importance of studies of this kind is well indicated in the foreword of the report, where it is stated that a recent survey of 320 farms in the Eastern Counties showed that labour accounted for 30 per cent, and machinery for 22 per cent, of the total cost of operating a farm. Reference is also made to estimates which indicate that, between 1939 and 1953, the productivity per worker attributable to mechanization increased by some 15 per cent only, whereas the " volume of machinery " in use increased by two and three-quarter times. Such figures can only be estimates, but few will disagree with the view that on many farms the increase in work performance has been small in comparison with the investment in mechanization—or with the results achieved by mechanization in, say, North America.

The district chosen for the study lies on the boulder clay in north Essex and south-west Suffolk. Data extending back to the period 1936-39 show that the number of manual workers has remained fairly steady at between 2.6 and 2.9 per 100 acres, the latest figure (1952) being 2.7. Two " modal " farms were selected, but the report only deals in detail with the medium-sized one (158 acres), which has a staff of four and a farm income (or profit) of £777 a year. Chief crops are wheat (37 acres), barley (37 acres), sugar beet (14 acres), mustard seed (12 acres), red clover (10 acres), and pasture (28 acres).

Labour requirements for the crops are very uneven, with peaks in late May, for sugar beet singling, in August, as a result of the grain harvest, and in October - November, due to sugar beet lifting. Steps proposed to reduce these peaks and thus cut the regular labour force from four to three are : (1) to use rubbed sugar beet seed and a one-man, mid-mounted tractor hoe in place of a two-man, steerage hoe ; (2) to introduce a 5-foot cut combine harvester ; and (3) to use a mechanical beet topper and lifter. Estimates of the labour which will be saved by these steps show that it is likely to be 170 man-hours in spring, 693 man-hours at corn harvest and 445 man-hours at root harvest, and the conclusion is reached that it will be possible to reduce the regular staff to three without greatly increasing dependence on casual labour. Savings, in the form of one man's wages, contract combining and threshing, total £542, while additional expenditure on depreciation and upkeep of the

new machines and extra casual labour reduce this by £223. Capital expenditure on new machinery is put at £800, so the increased profit of £319 a year seems a reasonable return.

The report next examines such new ventures as : (*a*) the introduction of a crop of peas for threshing in place of some of the grassland ; (*b*) introduction of a dairy herd, and (*c*) intensification of the pig and poultry enterprises. It concludes that the successful outcome of the changes in mechanization contemplated makes any or all of these enterprises practicable. With the existing labour force and mechanization the anticipated effect of the pea crop and the expanded pig and poultry enterprises would be to raise the farm income to £1,859 a year and to increase output per worker by 35 per cent.

All this is, of course, dependent on the ability of the farmer to choose suitable machines and to use them effectively and economically. Unfortunately there is no guarantee that he can do this, for it depends on other factors, such as training of the operators. There should be no difficulty in securing the large saving of labour by use of the combine harvester, but the outcome of introducing the new sugar beet equipment is perhaps a little more problematical.

Engineers Advance Art of Making Grass Silage. Paul A. Whisler and George V. Frushour. *Agric. Engng*, 1953, **34,** 315-8.

The writers begin by referring to the air of mystery, misunderstanding and confusion which surrounds the making and handling of grass silage. They point out that the job is not as difficult or as complicated as has been generally believed, and describe the making of 1,000 tons of silage each year for a period of eleven years, in the states of Wisconsin, Ohio and Indiana.

The work covered a wide range of crops including cereals, lucerne and clovers of various kinds, and was all done with forage harvesters, most of the silage being made with a machine working in the standing crop. Some experiments were done on windrowed crops, but generally farmers preferred the direct method. The length of chop ranged from a theoretical $\frac{3}{8}$ inch to $1\frac{1}{2}$ inches, but, apart from the fact that the shorter chop was preferred for drier crops, the length adopted for most crops was $\frac{3}{4}$ inch. In the early years, molasses or cereal meal was added, but as the experiments proceeded, the quantity of molasses or meal was reduced, until in 1952 none was used. The amount of time spent on spreading and trampling in the silo was also steadily reduced, and it was generally found sufficient in tower silos to take care with the top six feet. Success was always achieved, provided the following conditions were met : (1) the crop moisture content was over 70 per cent ; (2) the stage of maturity was not beyond the point where parts of plants were beginning to die ; (3) the crop was harvested by direct cut and chopped ; (4) ensilage took place immediately after cutting, in a silo which permits free drainage.

The results obtained were equally good with or without molasses, but silage made with the addition of cereal meals was not as good as that made without additives. Covering trench silos to prevent spoilage by rain seeping down the sides was found to be important.

The writers attribute the ease with which they were able to make good grass silage partly to the fact that the direct-cut forage harvester enables the silage to be got into the silo very quickly, and without contamination by the soil. Another advantage of this method is the saving in time and labour.

It must be remembered that this work was done in the United States of America, where conditions are in many ways different from those in Britain. The report does, nevertheless, suggest that the use of forage harvesters may be the key to easy silage-making in Britain, and that experiments in this country on similar lines might be of considerable value now that cheaper forage harvesters are becoming available.

C. C.

GLASSHOUSE CROPS

Luddington Experimental Horticulture Station Report for 1952

Spacing Experiments with Lettuce under Dutch Lights

Experiments were carried out at Luddington and at the Stockbridge Experimental Horticulture Station in Yorkshire to determine the optimum spacing for spring lettuce grown in double-span Dutch-light ranges, orientated north-south. Two varieties, May Queen and Attractie, were used at six spacings varying from 7 inches square to 11 inches square. The mean yield of marketable lettuce was 9.3 tons per acre at Stockbridge and 12.6 tons per acre at Luddington. At Stockbridge the highest yield came from the closest spacing (7 inches square) and at Luddington from the second closest spacing (8 inches triangular). The number of Grade I lettuces was independent of the spacing at both stations, and Attractie was the inferior variety. At Luddington, May Queen gave maximum numbers of Grade I lettuce with the 8-inch triangular spacing, and Attractie with the 9-inch square spacing. At Stockbridge, both varieties gave the highest numbers at the 7-inch square spacing. With May Queen and Attractie at Luddington, and May Queen at Stockbridge, the average cutting date varied with the spacing, cutting being later at the closer spacing. There was a difference between extreme spacings of 5½ days at Luddington for both varieties, and 5 days at Stockbridge for May Queen. There was no significant variation in the cutting date of Attractie at Stockbridge.

Orientation of Dutch Light Ranges

Another range of experiments affecting both Luddington and Stockbridge was designed to compare the effects of various orientations of single- and double-span Dutch-light ranges on two varieties of spring-grown lettuce, and also to compare the effect of two different slopes of glass. At both stations the total marketable weight of May Queen was superior to that of Attractie. At Stockbridge, the flat slope of glass gave a higher yield than the steep slope, and the difference was probably greater in double-span than in single-span ranges. The two orientations of double-span ranges produced insignificant differences in yield at both stations. South-facing, single-span ranges gave the highest yield at Luddington, but an anomalously low yield at Stockbridge. The effects of orientation and glass slope in double-span ranges on mean cutting dates were small at both sites. The mean cutting date from single-span ranges was earlier with the flat slope at both stations, the difference being significant at Luddington. Ranges facing south and west were generally earlier than those facing north and east.

Alternative Composts for Cucumbers

A small observation plot was planted in early July with the object of observing the difference, if any, between cucumber plants grown in the traditional compost and in John Innes compost (J.I.P.3), and to note, as a sub-treatment, the difference, if any, between plants which were allowed to fruit on the main stems and those which were not.

The traditional compost was made up of a 3-inch layer of strawy farmyard manure, surmounted with a compost of two parts loam and one part strawy farmyard manure, to which were added lime and fertilizers. The plants in J.I.P.3 compost, which were allowed to fruit on the main stem, yielded a total of 218 fruits weighing 174½ lb. ; those not stem-fruiting yielded 233 fruits weighing 189 lb. The plants in traditional compost and fruiting on the main stem yielded 173 fruits weighing 145½ lb. ; those not stem-fruiting yielded 194 fruits weighing 165 lb. Totals from stem-fruited plants in both treatments were 391 fruits weighing 320 lb., and, from the plants not stem-fruited, 427 fruits weighing 354 lb. It would appear that the J.I.P.3 compost maintained the plants in production over a longer period than did the traditional compost.

E. S.

FLOWERS

Long-term Holding of Cut Flowers. C. Fischer. *Proc. Amer. Soc. hort. Sci.*, 1953, **61,** 585-92.

The pre-packaging and dry cold storage of flowers is gaining ground in America as a means of spreading flower marketing. This paper is an interesting account of some extensive trials at Cornell University on a variety of different treatments and storage temperatures with a number of commercially important cut flowers. Only the more successful treatments will be mentioned.

Flowers were packaged before storage in a transparent wrapping in the form of a sleeve with the ends folded over and sealed with cellulose tape. (It is important that the size of the container should be such that the free air space is kept to a minimum.) There seemed to be no advantage in drying flowers before packaging, and standing in water beforehand was often deleterious ; in most cases, flowers stored best when packaged immediately after cutting. Carnations were stored successfully at 31°F. for up to five weeks and subsequently lasted in water for three to four days at 70-75°F. (the normal room temperature of American homes). Longer life after storage was achieved by putting the flowers in a proprietary compound containing sugar, aluminium sulphate and hexamethylenetetramine, instead of in water. Flowers stored at 36°F. appeared satisfactory at the end of the storage period but deteriorated more rapidly in water. At a storage temperature of 44°F. mould developed and the flowers were worthless.

Pompom chrysanthemums also stored excellently for one month at 31°F. but became mouldy at 36° and 44°F. Roses were successfully kept in dry packs at 31°F. for twelve days but deteriorated rapidly in quality at higher temperatures. Lily of the valley stored well at 31° and 33°F. but the life in water after storage was rather shorter than that of fresh blooms. Lilies, gardenias, cypripediums and cymbidiums could also be kept in dry packs for at least two weeks, and compared favourably with fresh blooms afterwards. Gladioli, however, proved unsuitable ; with dry storage at 31°F. the lower flowers on the spike shrivelled subsequently, while at higher temperatures the upper buds opened and the spike became worthless. Cattleyas in dry packs stored successfully at 45-50°F. but at lower temperatures browning of the column and the development of necrotic areas in the lip spoilt the blooms.

Preliminary Report on Copper and Zinc Naphthenate Treatments to Control Algae Growth on Clay Flower Pots. R. F. Stinson and C. G. Keyes. *Proc. Amer. Soc. hort. Sci.*, 1953, **61,** 569-72.

Algal growth on the outside of clay pots used for commercial pot-plants is a constant source of trouble and expense to growers ; unless removed by washing it reduces the value of the plants and makes handling difficult. This paper describes attempts to solve this problem by soaking

five-inch pots in various concentrations of copper sulphate, copper naphthenate and zinc naphthenate.

In the earlier experiments only zinc naphthenate in an oil carrier was used, and the plants tested were cyclamen, *Primula malacoides*, *P. obconica*, philodendron, nephrolepis, *Begonia Rex*, saintpaulia, cineraria and geranium. The treatment was very effective in preventing algal growth and, except with cyclamen, which was noticeably retarded in growth and flowering, little effect on the top growth of the plants was observed during eight months. Root growth, however, was considerably reduced and did not reach to the outside of the ball of soil.

More extensive tests were carried out in 1950-51 with the range of materials listed above, using geranium as the test plant. Zinc naphthenate (3 per cent zinc) again caused some retardation of growth, but the copper compounds did not noticeably affect the top growth, though root growth was retarded a little. All treatments, except copper sulphate, gave excellent control of algal growth and, on the whole, 14 per cent copper naphthenate (2 per cent copper) seemed to offer a promising treatment for commercial use.

Influence of Mineral Nutrition on Production, Rooting and Survival of Cuttings of Azaleas. W. H. Preston, J. B. Shanks and P. W. Cornell. *Proc. Amer. Soc. hort. Sci.*, 1953, **61**, 499-507.

There has been much conflicting evidence on the effect of the nutrition of the parent plant upon the rooting response of azalea cuttings, and this paper goes far to clear up these apparent contradictions. Of the three major nutrients, only nitrogen affected the results, variations in the phosphorus and potassium levels having no apparent influence upon the subsequent behaviour of the cuttings. As would be expected, the production of cuttings was significantly greater on high nitrogen plants and the shoots tended to be longer and a darker green. Rooting was markedly affected by the stage of maturity of the cutting in relation to the nitrogen supply to the parent plant. When succulent cuttings were used, those taken from plants receiving the low level of nitrogen showed a greater degree of rooting than did those on a high level. When mature cuttings were used, those from plants receiving the high level of nitrogen had the greater degree of rooting and also showed the higher survival rate.

Treatment of mature cuttings taken in November with a proprietary hormone dust resulted in better rooting, but the treatment had no effect with cuttings taken in May. Hormone treatment showed no relation to nitrogen supply to the parent plant.

R.H.S.

NUTRITION OF HORTICULTURAL CROPS

Seeds and Fertilizers

The placement of fertilizers close to horticultural seeds is inadvisable in some cases. The reasons for the differential behaviour of germinating seeds to NPK are not completely known, but the following two papers outline both the practical aspects of fertilizer placement and some of the mechanisms of possible benefit and damage.

Placement of Fertilizers for Row Crops. G. W. Cooke and F. V. Widdowson. *J. agric. Sci.*, 1953, **43**, 348-56.

Fertilizer placement experiments were carried out in peas, beans, carrots, beetroot and spinach. Fertilizers placed in a band three inches below the surface and two inches to the side did not damage germination and, in comparison with other forms of applications, gave the highest yields in one-third of the experiments. Soluble fertilizers drilled in contact with or below the seed of peas and beans are likely to cause damage.

The extra yields per acre produced by placing fertilizers were 1.8 cwt. of threshed peas, 9.3 cwt. of green peas, 1.0 cwt. of winter beans and 1.3 cwt. of spring beans. Yields obtained by a single dressing (2-3 cwt. per acre) of placed fertilizer were equal to, or greater than, yields given by a double dressing of broadcast fertilizers.

Where machines are not available for the side placement of fertilizers —and this will generally be the case—broadcast dressings given before sowing should be ploughed in. This applies particularly for carrot and beet, which fail to show any response to placement of fertilizer and thereby require the fertilizer to be broadcast.

In attempting to give reasons why placement is suitable for some row crops and not for others, it is suggested that those crops having a short growing season, or limited root range, benefit most. Secondly, placement is beneficial to crops susceptible to major nutrient deficiencies. Peas and spring-sown beans have a short season and peas also have a poor root system ; both crops are particularly responsive to placed fertilizers. Winter beans and beetroot, on the other hand, have a long growing season and show little benefit from such practices. Finally, spinach, which has one of the shortest growing seasons, showed a marked response to placing as against broadcasting.

On the question of modifying existing seed drills to do this kind of placement work, the " Suffolk " drill type is considered to be the most adaptable for large seeds.

The Origin of Toxic Ammonia in Germinating Garden Beet Seed. S. Rehm. *J. hort. Sci.*, 1953, **28**, 1-13.

Experiments on the germination of beet seeds showed that there is a marked difference between results obtained in germinating dishes and in soil. The work dealt specifically with " secondary " substances formed

during germination, as opposed to " primary " inhibiting substances present in the dry seed.

When a beet seed germinates, bacteria, apparently present on the seed, reduce nitrates to nitrite and, subsequently, to ammonia. The presence of ammonia is the postulated " secondary " substance which inhibits growth and kills the young roots. By disinfecting the seed, the development of bacteria can be stopped and the formation of toxic ammonia prevented.

Experiments with one kind of soil used for germinating untreated beet seeds produced entirely different results compared with laboratory tests. Germination in the soil was quicker and took place over a shorter time. It is assumed that any free ammonia produced by bacteria was absorbed by the soil.

This work indicates that substances formed by micro-organisms are probably the cause of many poor germination tests carried out in the laboratory.

W. P.

VEGETABLE CROPS

Methods of Measuring Soil Moisture Content

For many years attempts have been made to devise quick methods of measuring soil moisture content without disturbing the soil in the field. The moisture content of field soil *in situ* is subject to considerable local variation owing to the presence of stones, living roots, decaying vegetable matter, animal burrows and variable subsoil, and it is therefore desirable to be able to take the mean of a number of readings at different locations. Methods which have been used to measure soil moisture content include determinations of electrical resistance and capacitance, direct weighment of absorption plugs, resistance to mechanical pressure, and direct measurement of soil moisture tension.

Electrical Resistance [1]. A block of porous material is buried in the soil so that its moisture content comes into equilibrium with that of the soil. Various materials have been used for the blocks. Gypsum [2] is said to be useful in dry soils while nylon [3] and fibreglas [4 and 5] are better in wet soils. The durability of plaster blocks in wet soils has been improved by impregnating them with plastic resins [6]. This has had no effect on the electrical performance of the blocks. The resistance of the material to alternating current is measured by means of electrodes embedded in the block, and bears a relationship to the soil moisture content. The readings given by most resistance blocks show differences between the wetting and drying curves, and this causes difficulty in

interpreting the results. Gypsum and nylon blocks are obtainable commercially, together with the necessary a.c. ohm-meters, but the equipment is expensive and, as yet, hardly suitable for use by commercial growers.

Electrical Capacitance [7]. Some attempts have been made to derive moisture content from measurements of electrical capacitance, using the soil as the dielectric in a condenser, but no description of a satisfactory technique has yet been published.

Gravimetric Plug Method [2]. A block of porous material is allowed to come into moisture equilibrium with the soil at the required depth, and its moisture content is then determined by direct weighment. The method is accurate and simple in principle, but in practice the apparatus required is delicate and not yet suitable for commercial use.

The Stabilimeter [8]. This consists of a steel shaft which has spear-like projections at its lower end. The shaft is driven into the soil to the required depth and measurements are then made of the force required to rotate it axially. This is said to be related to the moisture content of the soil. The writer claims accuracy to within 0.5 per cent in heavy soils.

The Tensiometer [9 and 10]. A porous pot, filled with water, is buried in the soil and a manometer or vacuum gauge is arranged to indicate continuously the soil moisture suction exerted on the pot. Tensiometers are simple and reliable, but their range is limited to wet soils (below *p*F 2.8). For this reason they are more useful in greenhouses than in the field. They are available commercially in a form suitable for growers, but they are fairly expensive.

The Porous Pencil [11]. This device consists of a length of porous clay, the size and shape of an ordinary pencil, with a scale printed along the side. When its point is inserted in the soil, the pencil takes up water by capillarity, and the distance the water moves along the scale is taken as a measure of the water-supplying power of the soil. The pencil is impregnated with a dye which changes colour when wet. This instrument cannot be calibrated in any of the units normally used to describe soil moisture, but has proved very successful in comparative ecological studies. It is cheap and simple to use, and has only one big disadvantage—that a pit must be dug when determining soil moisture below the surface.

None of the methods described is entirely satisfactory. For use in glasshouses, tensiometers have many advantages over other instruments. It is possible that some adaptation of the porous pencil might be developed for commercial use. In the field, suitable electrical resistance blocks are the best instruments at present available, but none of the methods yet devised is as accurate or universally applicable as the laborious dry weight method based on the removal of soil samples.

A review of many *in situ* methods of soil moisture measurement has been compiled by B. A. Eastwell [12].

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E. J. W.

CROPS AND PLANT BREEDING

Colchicine-induced Variants Without Change of Chromosome Number

The action of colchicine in inducing chromosome doubling is by now widely known. In 1952 Franzke and Ross [1] reported that by treating sorghum seedlings they had induced striking variations in the treated plants without changing the chromosome number. The sorghum variety they used, though highly inbred and true-breeding, derived ultimately from wide crosses involving Sudan grass. The induced variants frequently showed characters reminiscent of Sudan grass and had the remarkable property of breeding true immediately.

As an explanation of this phenomenon, the writers, having in mind that sorghum ($2n = 20$) is " probably of polyploid origin ", put forward the suggestion that there had been somatic reduction of chromosomes followed by doubling to restore the original chromosome number.

Reporting the continuation of this work with sorghum, Ross, Franzke and Schuh [2] give data showing that the variant forms mentioned above bred true through five generations of self-fertilization. More recently they have treated seven seedlings of the same variety with colchicine, with the result that three of them produced progenies differing from the controls in height, number of tillers, stem diameter, number of leaves,

length and width of leaves, weight per seed, yield of straw and grain, and other more qualitative characters. Two of the three variant progenies were quite uniform and all had the normal chromosome number. It is mentioned also that colchicine treatment of sorghum varieties lacking very diverse ancestors does not usually produce variants.

N.I.A.B. Variety Trials

The current number of the *Journal of the National Institute of Agricultural Botany* includes reports of variety trials with maincrop potatoes [3], spring oats [4 and 5], spring barley [6] and flax [7]. These reports give a wealth of information on the performance of established and newer varieties at N.I.A.B. headquarters, at twelve regional trials centres, and also at many other sites which were included in the trials through co-operation with farmers and the N.A.A.S. It would be impossible to summarize these results adequately here, and all that can be attempted is to give some general impressions and refer to some conclusions of more general interest.

The maincrop potato trials (1942-52) demonstrate how difficult is the task of the potato breeder today. Bearing in mind that the new varieties tested are a small selection of seedlings sent in for observation, it is significant that of five new varieties introduced from 1942 to 1945 and deemed worthy of trial, two (Ulster Earl and Stormont Star) had disappeared by 1952, in the sense that no seed crops were certified, two (Stormont Dawn and Ulster Cromlech) had dropped sharply in the acreage certified, and the remaining one (Arran Viking) had only 61 acres certified in 1952. The trial results failed to indicate any variety likely to oust Majestic as the most popular maincrop variety.

In the spring oat trials (1942-52) no less than twenty-two new varieties came forward for trial. Of these, fourteen gave better yields than Victory, but only Blenda outyielded Sun II in a considerable number of trials. Sun II proved such a good all-round variety that it was adopted as control in the later trials. A new variety, which in a restricted number of trials gave yields at the Sun II level, was the Irish-bred Glasnevin Triumph. A mildew-resistant selection from the Welsh Plant Breeding Station considerably outyielded Victory, especially when mildew was prevalent, but in direct comparisons with Sun II its yield was a trifle lower.

From the varieties tested before 1949, Eagle, Opus, Star, Maldwyn and Milford were chosen for more extensive tests in secondary trials, with Sun II as control. These trials were conducted in 1949-51, in conjunction with the N.A.A.S. Resistance to lodging and to stem eelworm, susceptibility to mildew and lower yields distinguished Milford from the other five varieties, but otherwise there seemed to be only minor differences.

In the spring barley trials (1949-51), which were also staged in con-

junction with the N.A.A.S., the varieties compared were Freja, Spratt Archer, Kenia and Plumage Archer. Freja gave the highest average yield, was the earliest to mature and lodged rather more than Spratt Archer and Kenia. Plumage Archer gave the lowest average yield, the latest maturity and the worst lodging. Spratt Archer and Kenia were very similar in average yield and lodging, but Kenia matured some six days earlier than Spratt Archer.

Flax variety trials were conducted in 1950-52 in conjunction with H.M. Norfolk Flax Establishment, where material from the trials was processed. The varieties tested were Liral Prince (control), Hollandia, Percello and Stormont Motley. On field characters, the Dutch variety Percello was considered the best, though in maturity it is about a week later than Liral Prince and Stormont Motley. In the factory, the higher percentage of scutched flax characteristic of Stormont Motley often compensated for its lower yield of total crop. The final conclusion was that Percello was the best all-round variety.

Varietal Descriptions and Identifications

Morris [8] has given detailed descriptions of the wheat varieties, Cappelle Desprez and King II, and of the barley, Proctor. The same writer [9] has confirmed earlier work on the utility of the scale leaves at the first and second nodes of pea seedlings for varietal identification. (See also this Review, 1953, No. 19, 309). The seeds and scale leaves of over thirty varieties are illustrated by photographs.

Black Fly and Beans

Müller [10] has continued his work on varietal resistance to *Doralis fabae* in *Vicia Faba* (cf. also this Review, 1952, No. 15, 116). In seeking to find why four or five times as many winged aphids settled on the variety Schlanstedt as on Rastatt, he found that about equal numbers landed on each variety. But 10 per cent of those landing on Schlanstedt settled there, compared with only 1-2 per cent on Rastatt. Of those which landed but did not settle, the proportion leaving without ever inserting their stylets into the plant was 16 per cent in each case. Those which settled on Schlanstedt spent less time wandering about and made less trial probes than those settling on Rastatt.

These observations lead Müller to drop his earlier idea that Schlanstedt exerted its attraction at a distance, by smell. He now considers that the varietal difference begins to operate only after the aphids have landed, but is still undecided about the relative importance of taste, touch and smell.

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10. Über die Ursachen der unterschiedlichen Resistenz von *Vicia faba* L. gegenüber der Bohnenblattlaus *Doralis fabae* Scop. IV. Das Zustandekommen des Unterschiedlichen Initialbefalls. H. J. Müller, *Züchter*, 1953, **23**, 176-89.

J. L. F.

DAIRY HUSBANDRY

Milk Production

The current report of the Production Division of the Milk Marketing Board (*Milk Marketing Board, Report of the Production Division*, 1953, No. 4) gives further valuable information on the development of the national herd and on the milk recording and artificial insemination movements. The results of a number of investigations are also reported. During 1952-53 sales of milk off farms in England and Wales reached 1,602 million gallons, compared with 1,530 million gallons in 1951-52. Fortunately, the rise in production is not due entirely to a greater number of cows, but is also the result of a substantial increase in output per cow. For the country as a whole, an extra 140 gallons per cow were sold in 1952-53, compared with 1942-43. It is often stated that a substantial portion of the increased output per cow is due to a change from dual-purpose breeds to specialized dairy breeds. An investigation of the influence of this factor in milk-recorded herds showed, however, that breed changes were responsible for only 27 per cent of the increased yield per cow between 1942 and 1952. It would be difficult to disentangle the precise contribution of the other major factors bringing about the improvement in yield.

Hancock (*N.Z. J. Sci. Tech.*, 1953, **35**, 67-116), in one of his studies with monozygous twins, has provided further evidence that only a small percentage of the between-herd variations in production are genetic in origin and that feeding differences within the normal range of commercial practice can have a very great influence on the phenotypic expression of milk and butter fat. Other geneticists have reached similar conclusions in recent years, and it seems that the improvement in output per cow achieved in the brief period from 1942 to 1952 is likely to be mainly due to improvements in management, feeding and disease control. Nevertheless, the remarkable expansion in the use of well-bred bulls at artificial insemination centres, amounting now to over one million cows per year, or 39 per cent of the total in England and Wales, would seem

likely to ensure a gradual improvement in the milking potential of the national herd, if not in its actual yield. The Milk Marketing Board's report includes data on the number of herds from which bulls are obtained for the A.I. centres. In all the major breeds, bulls are purchased from a fairly large number of herds and it is concluded that there is little danger at present of too much in-breeding in the national herd.

Herd Fertility

The Milk Marketing Board report also gives a summary of the results of an investigation into the cause of low fertility in ninety-five herds where low conception rates had been reported. No evidence was obtained that vibriosis was spread by artificial insemination, but the disease appeared to be present in about one-half of the herds using natural mating. In a high proportion of herds (sixty-one out of ninety-five) low conception rates appeared not to be associated with known infection, and the conclusion was reached that breeding management, faulty nutrition or other unknown factors were involved.

It is sometimes stated that fertility is heritable and therefore a matter to be considered in the breeding programme. From a study of conception records of progeny of sires used for artificial insemination in New York State, Dunbar and Henderson (*J. Dairy Sci.*, 1953, **36,** 1063-71) conclude that selection for fertility cannot be very effective and that it would decrease the effectiveness of selection for production and type. This finding is in agreement with that of Pou, Henderson, Asdell, Sykes and Jones (*J. Dairy Sci.*, 1953, **36,** 909-15), who studied the breeding efficiency of several generations of Holstein and Jersey cattle in the Beltsville herd.

In an investigation in the State of Washington, Flerchinger and Erb (*J. Dairy Sci.*, 1953, **36,** 1072-6) have provided further evidence confirming that of Christian and Casida (*J. Dairy Sci.*, 1951, **34,** 971-7), that the fertility of the bull used at the first service can affect the conception rate for subsequent repeat services when carried out by semen from other bulls. No evidence is provided as to the extent to which this effect is due to vibriosis or other infections.

Milk Secretion

For some years it has been accepted that increasing pressure in the udder depresses secretion of milk into the udder. Owing partly to difficulty in measuring small changes in pressure in the udder without affecting the normal pressure changes, detailed information on this important aspect of milk production has been scarce. Recently, however, Nils Korkman (*K. Lantbr. Högsk. Ann.*, 1953, **20,** 303-36) has provided much valuable data on this matter. While there is a general correlation between the amount of milk in the udder and its internal pressure, many factors, such as the age of the cow, capacity of the udder, front and rear

quarters, level of yield, night and day interval etc., influence the correlation. Normally, the pressure inside the teat rises quickly to about 8 mm. Hg, due apparently to the hydrostatic pressure of residual milk draining into the teat. The rise in pressure is then slow but increases at an accelerating rate as the next milking approaches. The pressure during the first part of the interval between milkings is lower in the teats of young cows, but as the interval progresses the increase in pressure per unit of milk secreted is greater than in older cows, apparently because of the smaller udder capacity of the younger cows. Korkman's results support the view that shorter milking intervals are of greater importance to young cows than to old ones giving similar yields. This study also provides evidence that a high udder pressure inhibits the secretion of the non-fatty fraction of milk more readily than the fatty fraction. From this Korkman points to the possibility of a general negative correlation between fat percentage at a milking and internal udder volume.

A similar investigation has been carried out by Bailey, Clough and Dodd (*Nature*, 1954, **173,** 404-5). These workers studied the differences in the amount and fat content of milk obtained by normal machine milking at varying intervals between milking of from three to eighteen hours. In this work each of the selected intervals were applied several times consecutively so that the amount and quality of residual milk (which varies with the length of milking interval) became stabilized for the particular milking interval. By adopting this technique the transitory carry-over effect of a previous length of milking interval was eliminated, and entirely different results for milk quality were obtained compared with those where the intervals are changed after each experimental milking. It was found that the rate of true secretion of both milk and fat declined with increasing interval between milkings, particularly when the interval exceeded nine hours. The proportionate decline in milk secretion was, however, greater than that of fat secretion and, as a result, the fat percentage increased as the interval between milkings became longer. It seems, therefore, that udder pressure, which is affected by udder capacity, rate of secretion and interval between milkings, may be a more important factor affecting milk quality than has hitherto been appreciated.

Milking Method

Neave, Higgs, Simpkin, Oliver and Dodd (*J. Dairy Res.*, 1954, **21,** 10-8), have made a comparison between the incidence of mastitis in groups of cows stripped by hand and in groups stripped by machine after normal machine milking. They found little difference in new infection rate, nor in other estimates of the incidence of mastitis. Substantial differences, however, were found between the incidence in the two herds used, and the reasons for these are discussed. Mochrie, Hale, Eaton, Johnson and Plastridge (*J. Dairy Sci.*, 1953, **36,** 1223-32) have further investigated the comparative effect over a six-week period of a 10-inch and 17-inch Hg vacuum level and, at the same time, have investigated the effect of leaving the teat cups on the cow for twice and

four times the normal times. No effect on the common tests for mastitis was observed, as far as vacuum level is concerned, but higher leucocyte and chlorine values were found where the duration of milking was extended.

In a study involving forty-seven Holstein and Jersey cattle, Smith and Keyes (*J. Dairy Sci.*, 1953, **36,** 1178-81) could find no significant increase in milk produced in the lactation which followed prepartum milking started seven days before the date due to calve, compared with lactations where no prepartum milking took place.

Calf Feeding

Results of experiments to find ways of economizing in whole milk in calf rearing continue to appear in most dairying countries. New Zealand workers (*Ann. Rep. Animal Research Division, New Zealand Dept. of Agriculture,* 1951-52, 13) have found that, even at one week old, calves will graze for three-quarters of an hour daily, and by sixteen weeks for seven hours daily. Satisfactory growth has been obtained in Jersey calves on a total of no more than 31 gallons of whole milk plus 37 gallons of separated milk per calf. In Wyoming, Brown, Read and Willard (*J. Dairy Sci.*, 1953, **36,** 319-24) have obtained growth rates of over one pound per day up to 60 days, when replacing whole milk gradually with reconstituted whey from about two weeks old. In their investigations, scouring was controlled by adding $\frac{1}{4}$-teaspoonful of slaked lime to each feed of reconstituted whey. In Ohio, Hibbs, Pounden and Conrad (*J. Dairy Sci.*, 1953, **36,** 717-27) have paid particular attention to the early development of rumen function and establishment of suitable rumen micro-organisms by using liberal quantities of high quality roughage, particularly lucerne and timothy hay, from an early age. In these investigations, Jersey calves were reared in many cases on little more than 20 gallons of whole milk per head, and although growth was sometimes slow in the first few weeks, a rate of gain over one pound per day was usually achieved after the first few weeks. In these experiments no advantage was found for a complicated concentrate mixture containing animal protein, compared with a simple concentrate mixture of maize, oats, bran, soya-bean meal and minerals. No substantial increase in growth was obtained with a dry ration in the ratio of 2 parts hay to 1 part concentrates, compared with 4 parts hay to 1 part concentrates. These workers included in their experiments inoculation of the calf rumen with samples of fresh cud material from older cattle to provide rumen micro-organisms. There is, however, not much evidence so far from other stations that rumen inoculations are of general benefit in calf feeding. In one New Zealand experiment (*Ann. Rep. Animal Research Division, New Zealand Dept. of Agriculture,* 1951-52, 14) no significant gain in growth was obtained in twelve calves inoculated with cud from adult cows in the first, second and third week of life, compared with thirteen calves which were not inoculated.

A.S.F.

MYCOLOGY

Club Root of Brassicae

Factors Affecting the Survival of *Plasmodiophora brassicae* in the Soil and its Assessment by a Host Test. I. MACFARLANE. *Ann. appl. Biol.*, 1952, **39**, 239-56.

The degree of soil contamination by *Plasmodiophora brassicae* was estimated by counts of the numbers of root hair infections on seedlings and by the percentage of older plants which were clubbed. There was a linear relationship between the logarithm of the concentration of spores added to the soil and the logarithm of the mean number of root hair infection per seedling. The percentage of clubbed plants also gave a measure of soil contamination by the fungus, but this could be used only at the lower levels of soil contamination. In pot experiments the development of club root was favoured by the early application of fertilizers and a high level of soil nutrients ; this effect was most noticeable at low levels of soil contamination. In a wet, acid soil there was a rapid fall in infectivity within six weeks of adding spores to the soil. Dryness and alkalinity delayed this fall in infectivity, as did the addition of mustard oil to the soil. The suggested explanation is that there is a quicker germination of resting spores in the soil in wet, acid conditions. Experiments were made to test the possibility of various crops influencing spore germination, and the results indicated that crucifers and, in one case, ryegrass, might stimulate spore germination. In a fallow soil addition of nutrients had a similar effect. It was confirmed that zoosporangia and zoospores of *P. brassicae* could be found in the root hairs of non-cruciferous plants, including ryegrass, but the significance of this in relation to the survival of the fungus in the soil is not known.

A Study of the Epidemiology of Club Root Disease of Brassicae. JOHN COLHOUN. *Ann. appl. Biol.*, 1953, **40**, 262-83.

In naturally and artificially contaminated soils, Club Root occurred on cabbages in both acid and alkaline conditions. The factors influencing the incidence of the disease were generally the same as those affecting its subsequent development. In an acid soil (*p*H 6.3) seedlings were very readily infected when soil moisture was 70-80 per cent of the maximum water-holding capacity. More infection occurred at a mean temperature of 23.2°C. than at 18.4°C. A fluctuating soil moisture rising to at least 65 per cent of the maximum water-holding capacity was as favourable to infection as a constant high soil moisture. No infection occurred under constant or fluctuating low levels of soil moisture. Similarly, in an alkaline soil (*p*H 7.8) severe attacks of the disease occurred under conditions of constant or fluctuating high soil moisture and were more severe at a mean temperature of 23.8°C. than at a mean temperature of 17.5°C. It is suggested that the optimum temperature for infection may be above 23°C. In a further series of experiments a mean temperature of 10.8°C. inhibited infection even under conditions of high soil

moisture. With acid soil, there was almost the same infection at a mean temperature of 16.4 °C. as at 23.0 °C., but with an alkaline soil the higher temperature gave greater infection. The spore load, within the range 10^3 to 2.5×10^7 spores per gramme of dry soil, had little influence on the amount of infection in acid soil, except that with a dry soil a high spore load gave greater infection. In contrast, in an alkaline soil severe attacks of disease occurred only with a high spore load and the most favourable conditions of soil moisture and temperature. There was little difference in the incidence of the disease in different types of soils, except that under conditions unfavourable to infection more plants were diseased in the lighter soils. These results indicate that liming may control the disease if the concentration of spores in the soil is low. On the other hand, liming may be ineffective if the soil is heavily contaminated and soil moisture and temperature are favourable for infection.

Observations on the Incidence of Club Root Disease of Brassicae in Limed Soils in Relation to Temperature. John Colhoun. *Ann. appl. Biol.*, 1953, **40**, 639-44.

In these experiments, soil artificially contaminated with *Plasmodiophora brassicae* spores was limed until a *p*H of 6.9-7.3 was obtained at the start of each experiment. The water content of the soil was maintained at 70 per cent of the maximum water-holding capacity throughout the experiments. Pots were sown with cabbage seed and kept in a greenhouse, on a cool verandah, or alternated between the two. In pots kept continually in the greenhouse at mean temperatures of 23.1-24.8 °C. the disease developed readily. No disease appeared in pots kept constantly on the verandah at mean temperature of 12.3, 11.6 and 16.1 °C. Pots kept in the greenhouse for up to twenty-one days and then transferred to the verandah at 12.3 °C. or 11.6 °C. developed little disease. However, when kept six days or longer in the greenhouse and then transferred to the verandah at a mean temperature of 16.1 °C., severe attacks developed. It is suggested that in the open field in summer it is likely that plants would be exposed to favourable temperatures for sufficient time to induce a moderately severe attack of Club Root.

H. E. C.

N.A.A.S. QUARTERLY REVIEW INDEX

An Index of the articles and provincial notes contained in Nos. 13-24 will be issued with the Autumn number.

COMMONWEALTH AGRICULTURAL BUREAUX PUBLICATIONS

ANIMAL BREEDING

Animal Breeding Abstracts. In addition to abstracts, each number of this quarterly journal contains a review article on some topic of current interest to the research worker or advisory officer. Reviews in Vol. 21 included : " Factors Affecting Multiple Births in Sheep ", by E. C. Reeve and F. W. Robertson ; " Grazing Behaviour in Cattle ", by J. Hancock ; and " Advisory Work and Animal Husbandry ", by A. R. Wannop. A translation of an article by Ivar Johannson and Sven Eric Hildeman, entitled " The Relationship between certain Body Measurements and Liveweight in Cattle ", is reviewed in Vol. 22, No. 1.

Index to Animal Breeding Abstracts. Vols. 8-15, 1940-1947, 1952, 45s. A comprehensive subject index to abstracts published during and immediately after the war, when conditions made the compilation of indexes for each volume impossible. Indispensable for the full use of *Animal Breeding Abstracts.*

A World Dictionary of Breeds, Types and Varieties of Livestock. I. L. Mason. 1952, 30s. Contains over 4,000 entries, arranged according to species (ass, buffalo, cattle, goat, horse, pig and sheep) and country of origin.

The Genetics of the Dog. Marca Burns. 1952, 12s. 6d. The author has related a great deal of scientific work on inheritance to present-day dog breeding.

Gestation Periods : A Table and Bibliography. J. H. Kenneth, with additions by G. R. Ritchie. 3rd edition. 1953, 7s. 6d. Several hundred new entries have been added.

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FORESTRY BUREAU

Ever since its first issue in the summer of 1939, review articles or " leaders " have formed a regular and valued feature of the Bureau's quarterly journal **Forestry Abstracts.** Based always on world literature, they give the busy scientist an authoritative and objective conspectus in compact form of the current state of knowledge concerning some topic of wide forestry interest. More recent review articles that N.A.A.S. officers might find helpful in their work are : No. 13, " Chemical Methods for the Control of Weeds in Forest Nurseries " ; No. 15, " Methods of Testing the Germination Quality of Forest Tree Seed, and the Interpretation of Results " ; and No. 19, " The Use of Repellents for Preventing Mammal and Bird Damage to Trees and Seed ".

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PROVINCIAL NOTE

A CORN EXCHANGE STAND FOR ADVISORY WORK

A. R. Staniforth and I. E. Ketteringham

National Agricultural Advisory Service, East Midland Province

The present Lincoln Corn Exchange was opened in 1847. The main hall, 140 feet long and 52 feet wide, is as Victorian in appearance as King's Cross station. Nevertheless, like many of its kind, it performs as well as ever its function as a meeting place for merchants and farmers ; indeed, it is considered one of the best in the country for this purpose. Every Friday the cinema seats which occupy it for the rest of the week are wheeled out, 150 trade stands are brought in, and up to 500 farmers buy tickets to come in and do business in a wide variety of agricultural requisites from sacks to phenothiazine. Apart from some dealing in malting barley and seed corn, the trade in corn has been rather small during the recent era of fixed prices, but merchants are expecting many more farmers to bring in samples under the new marketing arrangements.

Early in 1950 a short article by one of our colleagues in the East Midland Monthly Notes suggested reviving the old idea of small advisory exhibits in the local market. This prompted us to stage a trial demonstration in the Corn Exchange at Lincoln, which is the market centre for most farmers in our area. The exhibit quickly became a weekly event and it is felt that our experience since July 1950 may be of interest to other advisory officers who have not previously tried this approach to the farming community. This may apply particularly to those who feel that, through the closing of district offices, they are losing a point of contact with farmers. It may be that the local corn market will provide a valuable alternative base for advisory work, for, although many of them are smaller than the Lincoln Exchange and relatively little business has been done in some of them in recent years, there seems every prospect of increased attendance in the future.

A Simple Layout

Our " stand " at Lincoln, which now costs £7 10s. a year, is a table, 3 feet 6 inches long by 2 feet 6 inches wide, set at the end of the Exchange opposite the entrance. To camouflage it, we wrap a white sheet round the legs, cover the top with a black cloth and prop a board at the end of the table as a background. A large stencilled heading for each demonstration is attached to the top of this board, which is visible from all parts of the hall.

We do not claim to have discovered anything new about the technique of staging small demonstrations. A bold, simple layout is our aim and

we use " live " material wherever possible. Topical, eye-catching matter which will attract interest and stimulate, rather than demand, some mental effort has always proved the best. Obviously some subjects do not lend themselves to this type of demonstration but, if such a subject is especially topical and important, we feel compelled to tackle it with diagrams and printed matter. A moribund pig would have been fine material for a Swine Fever exhibit, but we had to be content with a chart showing the annual incidence of the disease, together with syringes, vaccine and the latest leaflets. Incidentally, all labels and notices are stencilled. It is most important to have a neat and attractive layout. We show, and distribute when the interest warrants it, the official leaflets appropriate to the subject. Slides of local interest, shown through a viewer, are also useful at times, while a good working arrangement with the local press gives further publicity to the weekly topic.

After an extended trial, we decided that these small demonstrations should, if possible, be staged every week, because farmers and merchants had grown to expect them and looked for us, often with specific queries. Arranging a weekly exhibit is a considerable undertaking, but the fact that we share the job helps tremendously. We keep a few " made-up " exhibits which can be staged at almost any time, and the various specimens collected during the past four years make a useful reserve stock of material but, incidentally, occupy a good deal of storage space. County and provincial officers have been very helpful and have co-operated on a number of occasions.

There would be no point in describing individual demonstrations in detail ; no one else would prepare them in quite the same way. Much of the material (pest-affected and diseased crop plants, insects, fodder samples, etc.) is picked up in the course of normal farm visits. Farmers, firms and official stations have given generous help : the N.I.A.B. has supplied samples of grain and specimen ears of all the recommended cereal varieties ; the School of Agriculture at Sutton Bonington has given us many samples of potatoes ; local merchants and millers have provided various manures and feedingstuffs ; the N.I.A.E. has lent us models ; we borrowed ancient drainage tools, stuffed birds and fossils from the local museum ; and a Grantham tannery gave us warbled leather.

We are careful not to show material under proprietary labels. There is naturally a strong commercial atmosphere in the Corn Exchange and it has been quickly pointed out to us on occasions that we were emphasizing a rival firm's product ! Even the shape of dairy nuts or the colour of a seed dressing may be identified, and we therefore try to show all possible shapes and colours. In any matter of this sort it is particularly useful to be able to rely upon officially recommended products, varieties and practices. In showing cereals, for instance, we confine the demonstrated varieties strictly to those given in the latest N.I.A.B. leaflets, though, of course, in conversation we may deal with many others.

Advice on the Spot

Farmers frequently find it useful to be able to discuss with us, on the spot, the relative merits of different crop varieties or products which they contemplate buying, and sometimes they bring their merchant to our stand to discuss a particular point. By maintaining an unbiased attitude we find that our advice is valued by all sides. We are thus able to work in the closest co-operation with merchants and enjoy valuable exchanges of views with the technical representatives of the larger firms. This Corn Exchange stand influences merchants and seedsmen at least as much as farmers. We find that merchants appreciate information on technical matters and they, in their turn, exert a tremendous influence in their day-to-day contacts with farmers. It should be emphasized, however, that the exchange of information is by no means all in one direction—we ourselves learn a good deal from both farmers and merchants. However, perhaps the greatest advantage of these Corn Exchange demonstrations is that " live " material brings home a point more forcibly than a week's writing, and that this material is put before the farmer and merchant just when they are facing the particular problem.

In this business of helping to increase farmers' efficiency by persuading them to act on the best up-to-date knowledge, no single line of approach is the best. The stand at Lincoln is, we feel, a good method of approach, but we try to co-ordinate it with others. A recent demonstration on ventilated grain-storage bins, for instance, was staged immediately before a farmers' visit to a local installation.

As with so much of our advisory work, there is no simple yardstick to measure the value of these market demonstrations. The time spent preparing them obviously varies from week to week, but, on average, about an hour's work by each of us is sufficient both to prepare the material and to set out the stall. We have, until the present, been fortunate in having assistance from the staff of the district office in the stencilling of labels and diagrams—work which can take a good deal of time—and now have a large stock which can be used again. Several of the exhibits have been used at other markets and at meetings of farmers and young farmers, and this has clearly " spread the overheads ".

The Corn Exchange stand could, of course, be used simply as a known, weekly rendezvous—as indeed our stand was previously used by War Agricultural Committee officers. But the value of such a stand will be immensely increased if it can also be used as a " shop-window " for advisory material. From our contacts with merchants and farmers we feel that the extra work involved in preparing exhibits is well repaid by their appreciation and response.

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